FINAL REPORT

ENVIRONMENTAL RESOURCES MANAGEMENT

Report on Evaluation of the Fate of Benzene Discharged to the Slip Area at the Sasol North America Baltimore Facility

18 February 2008

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EXECUTIVE SUMMARY

Sasol North America (Sasol) retained Environmental Resources Management, Inc. to investigate the dissipation of a benzene release to the Slip at the Sasol Baltimore Facility. The release occurred between 15 and 16 February 2007. A total of 300 lbs of benzene were discharged to the Slip resulting in a surface water concentration of benzene at approximately 10 milligrams per liter (mg/L) immediately following the release. The water in the Slip was treated using an activated carbon filtration system; however by the time the carbon system was installed, the concentrations of benzene in surface water had decreased to approximately 1 to 2 mg/L. The Slip is not in direct hydraulic communication with the Patapsco River, having been isolated from the river by the installation of sheet piling during the mid 1970's.

The MDE RCRA group recommended that Sasol evaluate the fate and transport of the benzene release to explain the potential natural mechanism that caused the 300 pounds of benzene to dissipate and determine whether it dissipated in an environmentally benign manner. Possible sinks for the benzene that were identified and considered were: volatilization, sorption to sediments, biodegradation, and discharge to ground water.

The benzene sinks were evaluated through a combination of empirical data evaluation and contaminant fate and transport modeling. Sorption of benzene to sediments was evaluated by analysis of surface water and sediment samples. Discharge of benzene to ground water was evaluated by analysis of ground water samples. Contaminant fate and transport modeling was used to evaluate the ability of volatilization, sorption to sediments, and biodegradation to cause the observed concentrations of benzene to dissipate.

The results of the sample analyses and the model output indicate that volatilization is the most likely method by which benzene dissipated from the Slip surface water. The sediment sample results do not indicate that the released benzene is being held in sediment. Contaminant fate and transport modeling confirms that only 0.01% of the released benzene (0.03 pounds) would be expected to be taken up by sorption. The ground water sample results do not show increases in benzene when compared with samples collected before the release. Biodegradation was eliminated as a possible sink due to the very cold ambient temperatures at the time of the release.

1.0 INTRODUCTION

Environmental Resources Management (ERM) has prepared this report to present the findings of the remedial investigation for a release of benzene to the on-site Slip Area. Figure 1 shows the site layout and the location of the Slip. The Site is a chemical manufacturing facility located at 3441 Fairfield Road in Baltimore, Maryland. The facility is currently in the process of shutting down, and the manufacturing processes are no longer operational. The investigation was conducted according to the methods described in the document titled *Work Plan to Evaluate the Fate of Benzene Discharged to the Slip Area at the Sasol North America Baltimore Facility* dated 22 October 2007 (ERM, 2007).

1.1 BACKGROUND

Between 15 February 2007 and 16 February 2007, approximately 300 pounds of benzene, dissolved in untreated wastewater, was discharged into the Slip. Initial concentrations of benzene in the Slip water after the discharge were approximately 10 milligrams per liter (mg/L). The Slip water was treated using an activated carbon bed, but by the time the carbon bed had been installed, the concentrations of benzene in the Slip water had decreased to 1 to 2 mg/L. The Slip is not in direct hydraulic connection with the Patapsco River, having been isolated from the river through the installation of sheet piling during the mid 1970's.

A detailed review of the historical data for the slip area and the spill timeline are presented in the Work Plan and summarized herein. Surface water collected by Sasol North America (Sasol) prior to, during, and after the benzene release and subsequent treatment are presented in Table 1. This table also shows the timeline of mitigation measures completed by Sasol (Sasol, 2007). The surface water sample locations are shown in Figure 2. Figure 3 presents the surface water data collected by Sasol in graphical form showing the decrease in benzene concentrations over time.

The MDE RCRA group recommended that Sasol evaluate the fate and transport of the benzene release to explain the potential natural mechanism that caused the 300 pounds of benzene to dissipate and determine whether it dissipated in an environmentally benign manner. Possible sinks for the benzene that were identified and considered include:

- Volatilization into the atmosphere;
- Adsorption to sediments;
- Biodegradation; and
- Discharge and transport to ground water.

1.2 *PROJECT OBJECTIVE*

The objective of the Slip Area assessment was to determine the most likely fate of the benzene discharged to the Slip during the February 2000 release. The assessment consisted of the collection of additional empirical data to support modeling efforts and to determine if any benzene remained in Slip sediments or had migrated into ground water in the vicinity of the Slip.

The scope of work to complete the Slip Area assessment included four tasks:

- A review of existing data;
- Collection and analysis of surface water, sediment, and ground water samples to supplement previously existing data;
- Contaminant fate and transport modeling; and
- Reporting.

The review of existing data was completed as part of the Work Plan. The methods and results for the additional sampling activities and contaminant fate and transport modeling are presented in Sections 2.0 and 3.0, respectively, of this report. Section 4.0 presents the conclusions.

2.0 METHODS

2.1 CONCEPTUAL APPROACH

The potential sinks for benzene from the Slip surface water are as follows:

- Volatilization into the atmosphere;
- Adsorption to sediments;
- Biodegradation; and
- Discharge and transport to ground water.

Certain of these sinks could be tested empirically, while others required a modeling approach.

The degree to which benzene sorbed to sediments at the bottom of the Slip, or to sediments in the water column that settled to the bottom of the Slip was investigated using empirical data (sediment samples collected in April 2007 and in November 2007). Similarly, ground water data from the monitoring wells surrounding the Slip could be sampled in order to determine whether any of the wells showed increases in benzene concentrations since the February 2007 discharge to the Slip. Existing hydrogeologic data was also used to evaluate how quickly water discharged from the Slip to ground water could be expected to reach the surrounding wells.

The degree to which benzene may have volatilized to the atmosphere or undergone biodegradation could not be measured directly. Therefore, contaminant fate and transport modeling was required to assess the degree to which these two mechanisms might be expected to account for the decrease in benzene in the Slip water. Sorption to sediments and biodegradation were also considered in the construction of the model.

2.2 SAMPLE COLLECTION AND ANALYSIS

It was determined that empirical data were necessary in order to supplement existing sample data for sediment and ground water and to fill data gaps to support the contaminant fate and transport modeling.

The collection of additional samples included surface water, sediment, and ground water samples.

2.2.1 *Surface Water Samples*

Surface water samples were collected on 12 November 2007. Two surface water samples (SW-1 and SW-2) (Figure 2) were collected to update Sasol's surface water data collected in early 2007 in response to the benzene release. The samples were collected from a boat using clean, dedicated bailers from the middle of the Slip water column. The samples were analyzed for:

- Benzene, toluene, ethylbenzene, and xylenes (BTEX);
- Total suspended solids (TSS), total organic carbon (TOC); and
- Natural attenuation parameters (sulfate, chloride, alkalinity, dissolved gasses, and dissolved iron).

One blind duplicate sample (SW-3) was collected from the same location as SW-2 for quality assurance/quality control (QA/QC purposes).

2.2.2 *Sediment Samples*

Sediment samples were collected on 12 November 2007. A total of four sediment samples were collected from the same locations as historic sediment samples SED-2, SED-3, and SED-4 (Figure 2). These locations were selected because they were the only historic sediment samples to contain detectable benzene (ERM, 2006 and ERM, 2007b). ERM attempted to collect the samples using a steel dredge, as described in the Work Plan; however, the dredge was found to be ineffective due to the consistency of the substrate. The sediment samples were collected using a clean, dedicated segment of PVC pipe to collect the sediments. The PVC pipe was pressed into the sediments, capped, and extracted from the water. The sediment samples were analyzed for BTEX.

2.2.3 *Ground Water Samples*

Ground water samples were collected on 28 through 30 November 2007. A total of seven ground water samples were collected from the shallow and intermediate depth wells in the Slip Area (MW-5S, MW-8S, MW-5I, MW-8I, MW-17I, P93-4, and P93-5) (Figure 1). The samples were collected using low-flow purging and sampling techniques. Field parameters (pH, conductivity, temperature, dissolved oxygen, oxidation reduction

potential, and turbidity) were monitored in the field and samples were collected once parameters had stabilized. The ground water samples were analyzed for:

- BTEX,
- MTBE, and
- Natural attenuation parameters.

Part of the data review presented in the Work Plan included a review of existing ground water flow data (ERM,1989). A seepage velocity of 40 to 80 feet per year (ft/yr) was calculated for ground water in the Slip Area. At this flow rate, it was anticipated that benzene discharged to ground water from the Slip would require over a year to reach MW-17I, located approximately 100 feet from the edge of the slip. Although the ground water samples were collected only nine months after the benzene release, seepage velocities are estimates and can be higher or lower depending upon changes within the aquifer formation along the flow path; therefore, collection of ground water samples in November 2007 provides useful data as to whether the release of benzene to the Slip has impacted ground water.

2.3 *SURFACE WATER MODELING*

The fate of benzene in the Slip prior to initiation of activated carbon treatment was be modeled using ERM's Generalized Environmental Modeling System for Surface Waters (GEMSS) coupled with the Chemical/Oil Spill Impact Module (COSIM). The GEMSS-COSIM model is used to evaluate the impacts of volatilization, adsorption, sedimentation, and biodegradation of organic contaminants. GEMSS and the several related modules, including COSIM have been approved for use in evaluating surface water processes by the U.S. National Oceanic and Atmospheric Agency (NOAA), the U.S. Environmental Protection Agency (USEPA), and several state agencies. Further information on agency approvals of the GEMSS-COSIM model and summaries of previous applications of it are provided in Appendix A of the Work Plan.

Details regarding the model input parameters for the Slip area are presented in Appendix A of this report. In brief, the model input parameters included:

- The measured dimensions of the Slip;

- The initial input of benzene (300 pounds of benzene, dissolved in approximately 120,000 gallons of untreated waste water);

- The concentration of total suspended solids in the Slip water (as determined from surface water samples collected as described in Section 2.1.1);

- Water temperature approximated using historical meteorological data obtained for the area during the time of the spill; and

- Salinity of the Slip water, approximated at 6 parts per thousand (ppt), based on salinity profiles provided by Maryland's Department of Natural Resources (MDNR, 2008).

Although agitators are present in the Slip and were turned on once the benzene release had been discovered, their influence was not included in the model. Biodegradation was removed from consideration in the model because the low temperatures during the period of the spill make it reasonable to assume that the rates of biodegradation would be negligible. Transport to ground water was not directly accounted for in the model; however, this pathway was investigated by calculating ground water flow velocity and collecting additional samples in the Slip area, as described in Section 2.2.3.

3.0 RESULTS

3.1 ANALYTICAL RESULTS

3.1.1 Surface Water

Table 2 presents the data for the surface water samples collected in November 2007, and laboratory report is included in Appendix B. No VOCs were detected. The natural attenuation data show that there are no elevated concentrations of iron or methane and the concentration of sulfate is neither particularly high nor particularly low. These indicators show that the water in the middle of the water column is at least somewhat oxidizing, which is beneficial for degradation of organic compounds such as benzene.

The levels of TSS and TOC were measured in order to determine the degree to which dissolved benzene may have adsorbed to sediments. The results for TSS were 5 mg/L at SW-1 and 4 mg/L at SW-2 and for TOC were 1.5 mg/L at SW-1 and 2.1 mg/L at SW-2. It should be noted that this analysis assumes that the TOC and TSS levels in November 2007 were the same as in February 2007 during the benzene release. The operation of the agitators during the hours following the benzene release could have increased the TSS levels in the Slip during that time period, however, the fact that the agitators are located at the top of the Slip water column, rather than at the bottom, tends to limit the amount of sediment that they would be expected to stir up into the water column. The TOC levels in the sediment would not be expected to change significantly between February and November 2007 as the source of sediment materials to the Slip did not change.

3.1.2 Sediment

Table 3 presents the data for the new and historic sediment samples, and laboratory data are included in Appendix B. VOCs were detected in all three sediment samples and the blind duplicate sample. The results are also summarized below:

- **SED-2** contained the highest concentration of benzene (2,900 µg/kg). This concentration is higher than that detected in April 2007, two months after the benzene release; but not as high as the concentration detected in August 2006. Sample SED-2 also

contained elevated levels of toluene, ethylbenzene, and xylenes, which were not detected during previous sampling events.

- **SED-3** contained a low concentration of m,p xylenes (51 µg/kg) but no other detectable VOCs.

- **SED-4** contained low concentrations of benzene, ethylbenzene, and total xylenes (23 µg/kg, 31 µg/kg, and 187 µg/kg, respectively). The concentration of benzene is lower than that detected in April 2007.

The sediment sample results indicate that some benzene is present in the Slip sediments, along with lower levels of other BTEX parameters. With the exception of location SED-2, the results were not higher than the April 2007 results, indicating that widespread settling of sediments in the water column with significant amounts of adsorbed benzene has not occurred. The elevated concentration of benzene at location SED-2 is likely due to some localized benzene impacts to the sediments that existed prior to the February 2007 release. The presence of toluene, ethylbenzene, and xylenes (which are not related to on-site operations) indicates that the sediments have been impacted by off-site sources rather than the February 2007 benzene release.

The fact that benzene was not detected in the surface water samples indicates that the Slip sediments are also not releasing benzene back into the surface water.

3.1.3 Ground Water

The analytical data for the ground water samples are presented in Table 4. Also presented in Table 4 are the historical analytical data for each monitoring well. The laboratory reports are included in Appendix B. The results are summarized below:

- **MW-05S** – Benzene was detected at a concentration of 8 µg/L, which is comparable to the levels observed over the last 19 years. MTBE was also detected at a concentration similar to historic results.

- **MW-05I** – Benzene was detected at a concentration of 6 µg/L. This concentration is comparable to the levels observed at this well over the last 12 years. MTBE was also detected at levels comparable to historic samples.

- **MW-08S** – Benzene was detected at a concentration of 9 µg/L. This level is higher than that observed in previous years (1988 through 1999). MTBE was also detected at 2 µg/L, which is lower than the only historical result for this compound (12 µg/L detected in 1999). It should be noted, however, that this sampling event represents the first time the well has been sampled in 7 years.

- **MW-08I** – Benzene was detected at a concentration of 2 µg/L. Benzene has not previously been detected at this monitoring well. No other VOCs were detected. Like MW-08S, this sampling event represents the first time this well has been sampled in 7 years.

- **MW-17I** – Benzene was not detected. The only other VOC detected was MTBE at a level comparable to historic results.

- **P93-4** – Benzene was detected at a concentration of 10 µg/L (8 µg/L in the blind duplicate sample). No other VOCs were detected. These results are comparable to those observed at this location over the last 3 years.

- **P93-5** – Benzene was not detected. The only VOC that was detected was MTBE at a level comparable to historic results.

Based on the above observations, the only wells that show an increase in the concentration of benzene in ground water are upgradient wells MW-08S and MW-08I. It should be noted however, that benzene concentrations at these wells are less than 10 µg/L and are similar to benzene levels detected in ground water across the Site. These wells also had not been sampled in approximately 7 years. Consequently, it is possible that the benzene at wells MW-08S and MW-08I are related to one or more upgradient, offsite impacts that have arisen within the last 7 years rather than to seepage of benzene-impacted water from the Slip into ground water.

The presence of ethylbenzene, toluene, xylenes, and MTBE in the ground water samples indicate impacts associated with off-site gasoline sources.

3.2 *SURFACE WATER MODELING*

A detailed discussion of the surface water modeling results is provided in Appendix A. The significant findings are presented below.

The modeling calculations for benzene sorption to sediments showed that the fraction of benzene expected to partition into the Slip sediments was less than 0.01% (i.e. 0.03 pounds of benzene out of the approximately 300 pounds of benzene that were discharged). Thus, sorption to sediments was calculated not to be a sink for benzene in the Slip.

The remainder of the modeling focused on volatilization of the dissolved benzene. Figure 6 shows the distribution of total benzene mass between the Slip water and the atmosphere, as calculated by the GEMSS COSIM model. The model was also used to calculate the expected concentrations of benzene at four points along the edges of the Slip (Figure 7). The modeled concentrations (assuming loss of benzene through volatilization only) at these four locations are plotted against the measured concentrations of benzene in the Slip, as provided by Sasol, in Figure 8.

As the Slip is isolated from the Patapsco River, the model did not include any type of currents or flow within the Slip. Thus, the highest initial concentration, according to the model, appears at the discharge point and it takes some time for the elevated benzene concentrations to be distributed across the Slip. The empirical surface water data provided by Sasol, however, shows that benzene was detected at comparable levels in all areas of the Slip very quickly after the release. This is likely due to the operation of the agitators. Nevertheless, comparison of the modeled benzene concentrations to the measured benzene concentrations shows that the model predicts a faster decrease in benzene concentrations than was actually observed.

Although the modeled concentrations shown in Figure 8 do not take into consideration possible losses due to biodegradation or leakage to ground water, the model results show that volatilization is sufficient to explain the observed decrease in benzene concentrations over time.

4.0 CONCLUSIONS

The findings of the Slip area assessment indicate that volatilization is the sink for benzene that was discharged to the Slip. Surface water modeling shows that, given the environmental conditions at the time of the release and the physical properties of benzene, the calculated rate of volatilization is sufficient to explain the observed decrease. Biodegradation and sorption to sediments were eliminated as likely sinks due to the cold temperatures at the time of the release and low levels of suspended solids in the Slip water, respectively. Although benzene was detected in one sediment sample at a concentration of 2,900 µg/kg, this concentration is lower than the concentration detected in 2006, prior to the February 2007 benzene release. In addition, contaminant fate and transport model results indicate that only 0.01% of the discharged benzene would be expected to sorb to sediments. Therefore, the benzene concentration in this sediment sample appears to represent localized sediment conditions that are not related to the February 2007 benzene release to the Slip.

The surface water model did not include loss of benzene to the ground water; however, ground water samples collected from wells surrounding the Slip were comparable to historical ground water data. It should be noted that the calculated ground water velocity in the Slip area is slow and it is still possible that ground water impacted with benzene from the Slip has not yet had time to reach these monitoring wells. Continued monitoring of some or all of the Slip area wells will show whether increases in benzene, potentially from the Slip, do occur. Sasol currently monitors wells MW-05S, MW-17I, and P93-5 annually and well MW-05I semi-annually. This program should be sufficient to monitor ground water in the Slip Area for potential benzene impacts.

5.0 *REFERENCES*

ERM, 1989. Phase 2 Ground Water Assessment at the Vista Chemical Company. Prepared for E.I. du Pont de Nemours and Company, Inc., 5 June 1989.

ERM, 2006. Sediment Sample Results for the Slip Area. Prepared for Sasol, North America by ERM, September 2006.

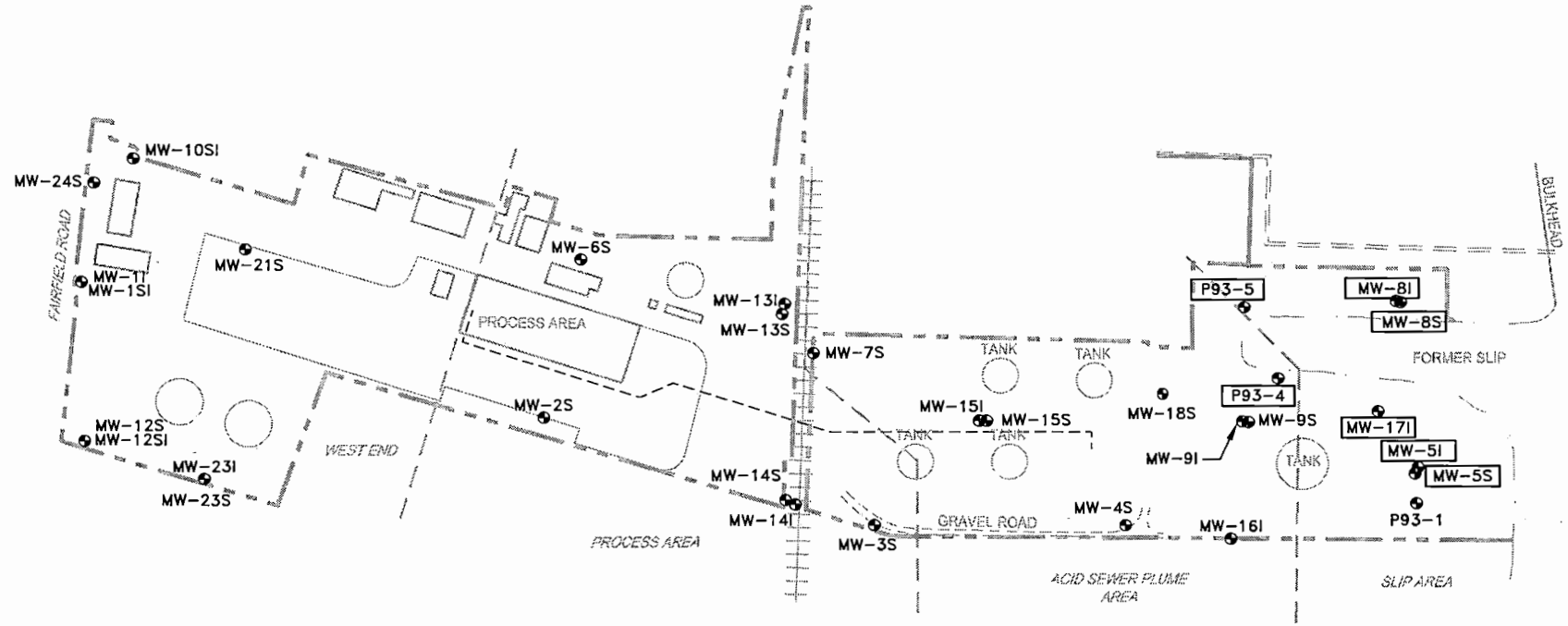
ERM 2007a. Work Plan to Evaluate the Fate of Benzene Discharged to the Slip Area at the Sasol North America Baltimore Facility. Prepared for Sasol, North America by ERM, October 2007.

ERM, 2007b. April 2007 Sediment Sample Results for the Slip Area. Prepared for Sasol, North America by ERM, May 2007.

Sasol, 2007. Slip Area Data. Electronic Mail Communication from David Mahler (Sasol, North America) to Robin Guynn (ERM), September 2007.

FIGURES

FIGURE 1
SITE LAYOUT MAP
SASOL NORTH AMERICA
BALTIMORE, MARYLAND



LEGEND

- PROPERTY LINE
- RAILROAD
- FORMER ACID SEWER (REMOVED 1990)
- MONITORING WELL LOCATION
- MW-5S — MONITOPRING WELL SAMPLED AS PART OF SLIP AREA ASSESSMENT NOVEMBER 2007

500 250 0 500

SCALE IN FEET

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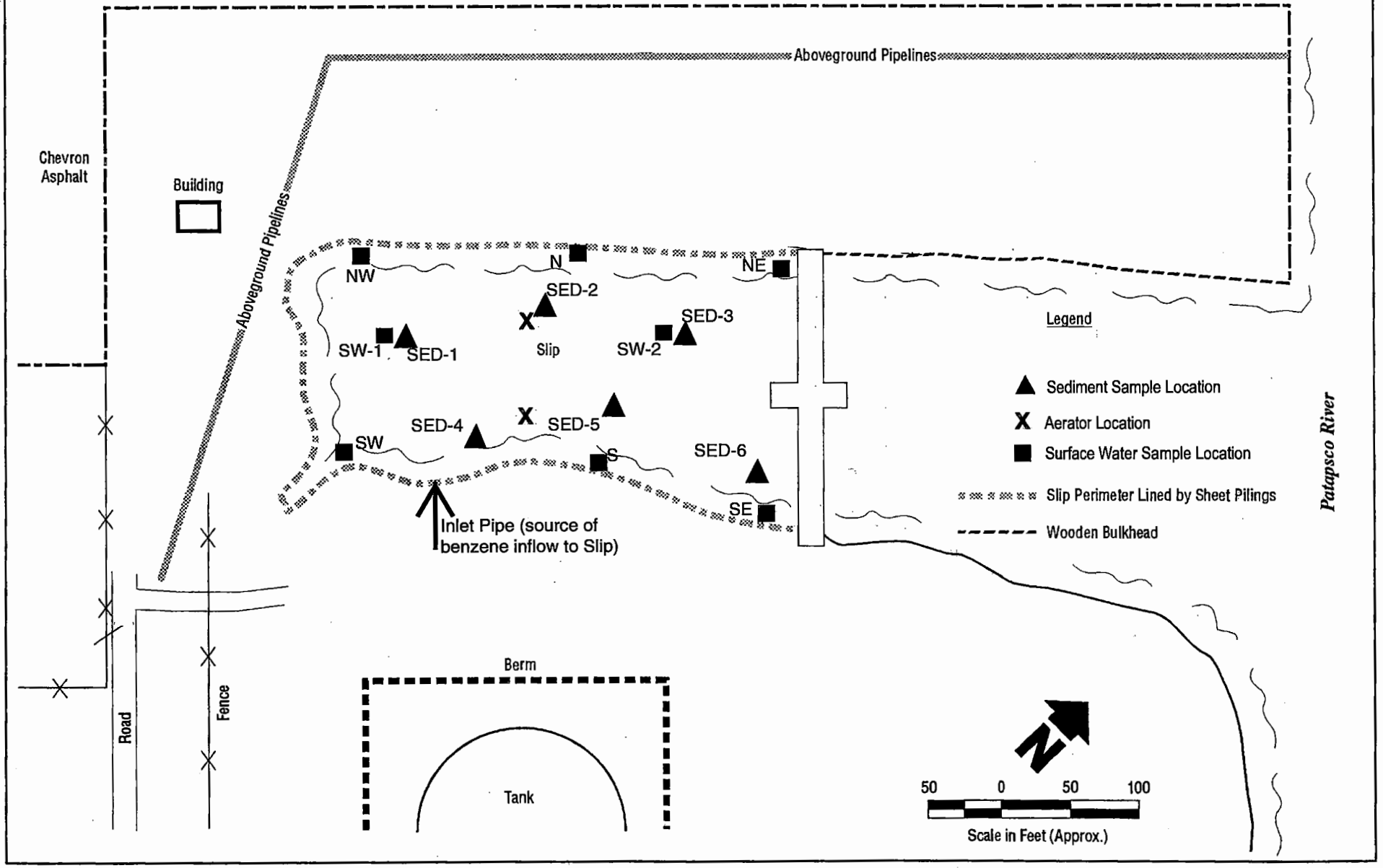
Figure 2
Surface Water and Sediment Sample Locations
Sasol North America, Baltimore, Maryland



ERM, INC.

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Figure 3
Concentration of Benzene in Slip Water Over Time

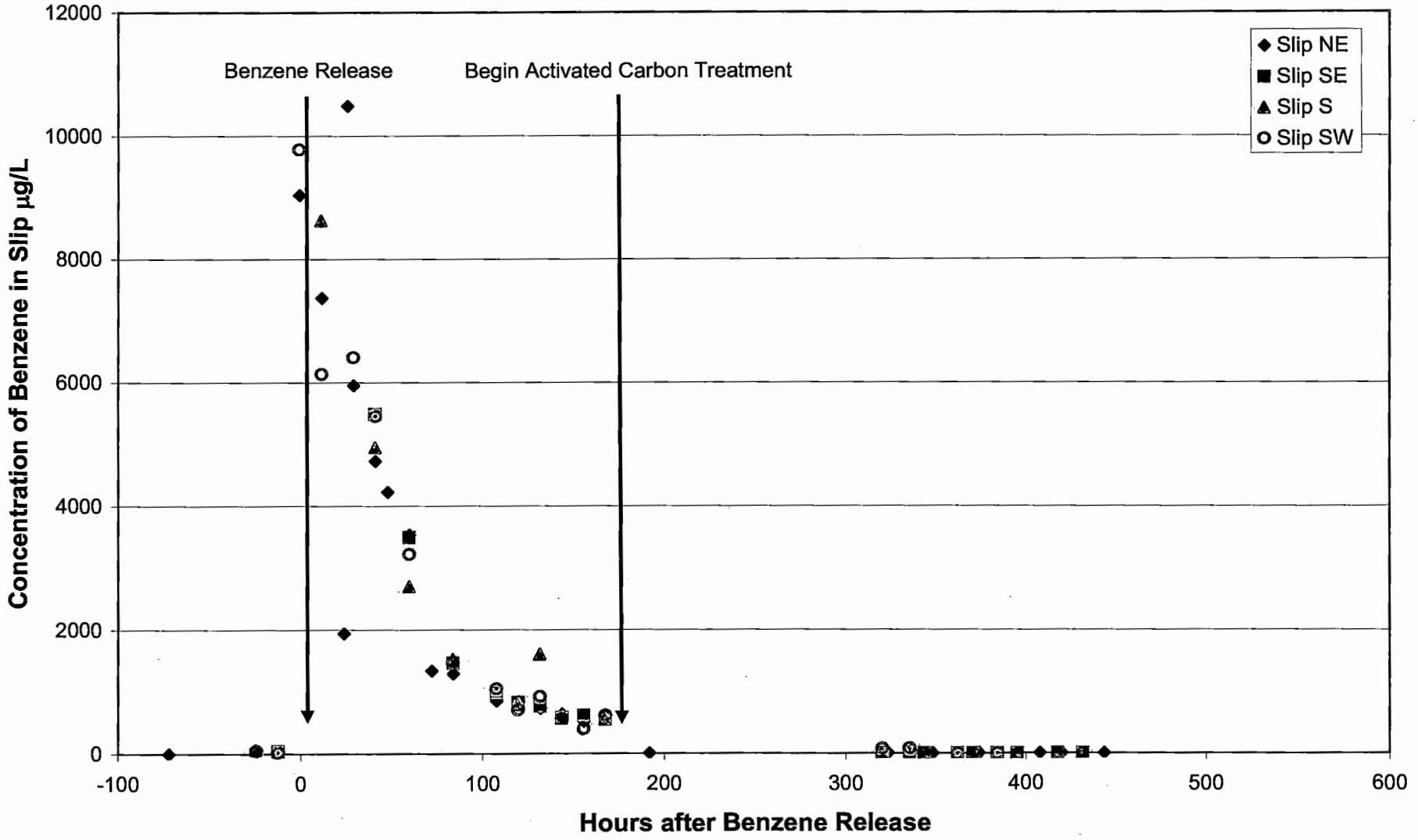
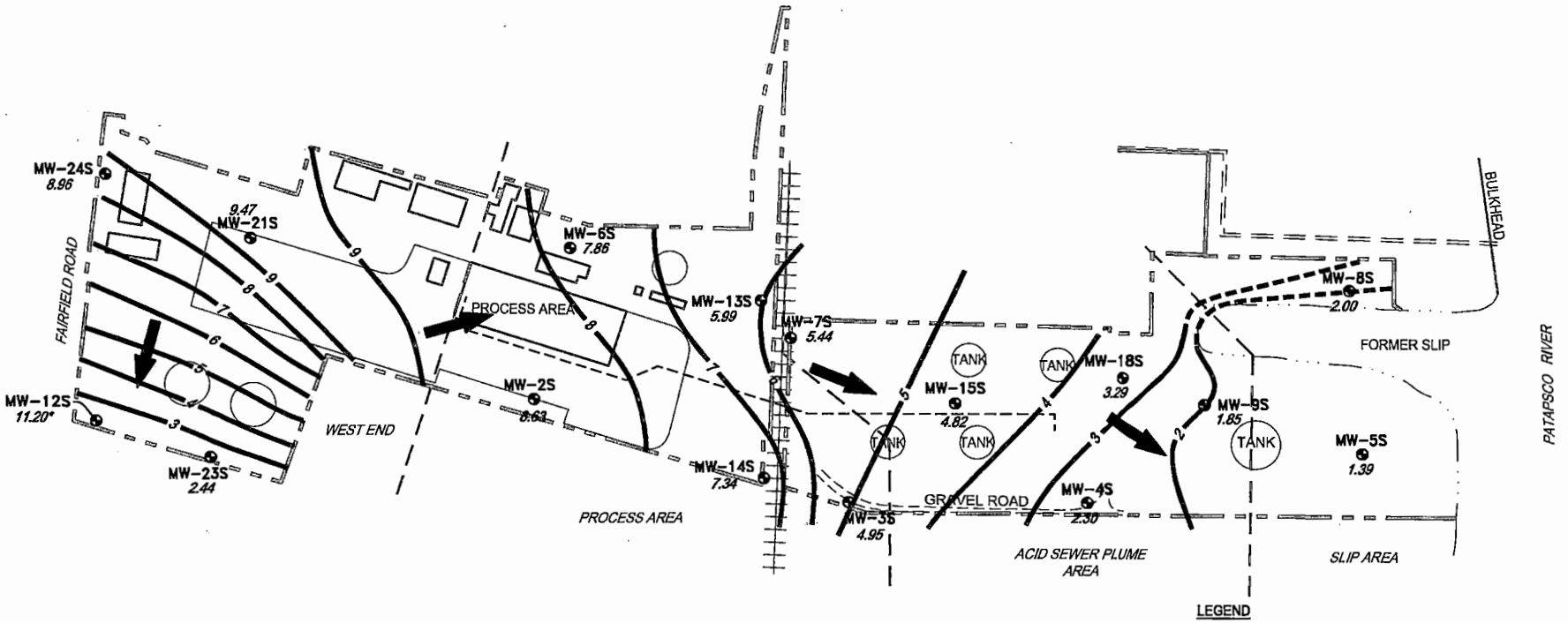


FIGURE 4
GROUND WATER CONTOUR MAP FOR UPPER ZONE
12 NOVEMBER 2007
SASOL NORTH AMERICA
BALTIMORE, MARYLAND



LEGEND

- PROPERTY LINE
- RAILROAD
- FORMER ACID SEWER (REMOVED 1990)
- MONITORING WELL LOCATION
- 2 — GROUND WATER CONTOUR (FEET MSL) (DASHED WHERE INFERRED)
- 1.39 — GROUND WATER ELEVATION (FEET MSL)
- GROUND WATER FLOW DIRECTION

NOTE:
* INDICATES NOT INCLUDED FOR GROUND WATER CONTOURS

500 250 0 500

SCALE IN FEET

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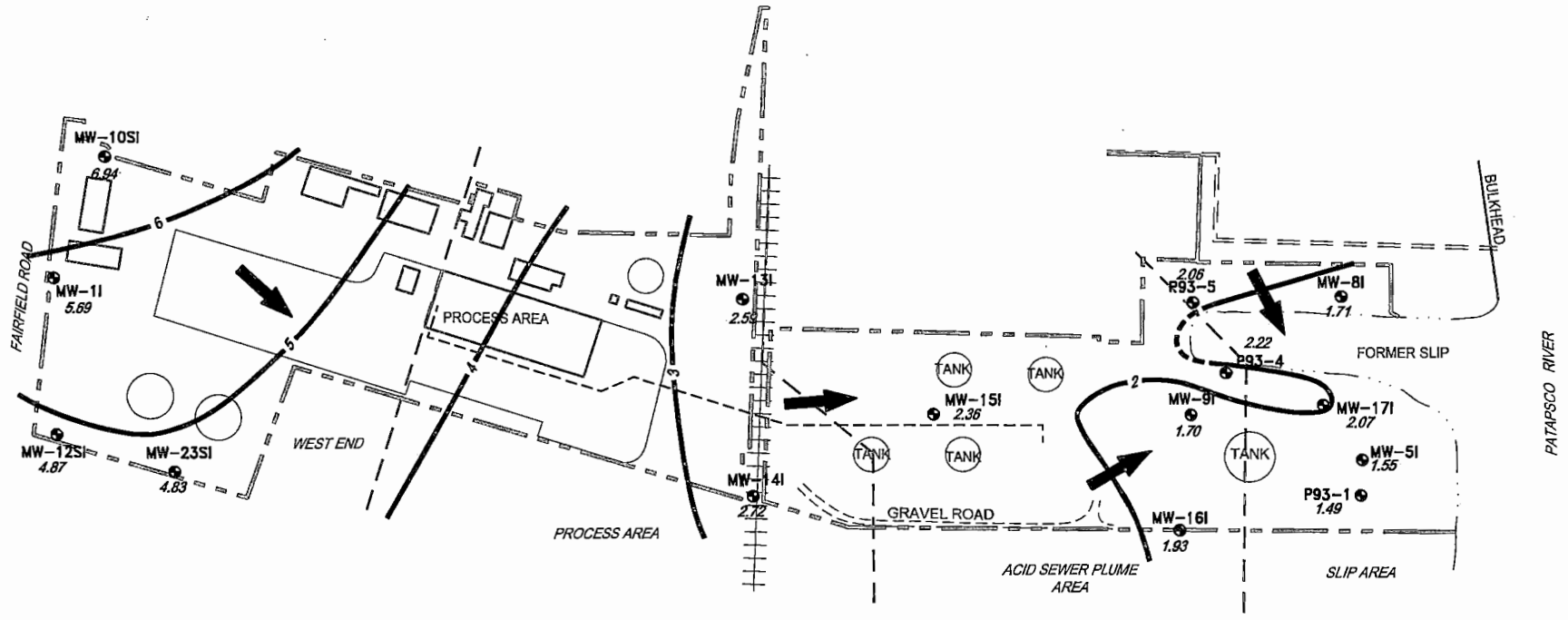
FIGURE 5
GROUND WATER CONTOUR MAP FOR LOWER ZONE
12 NOVEMBER 2007
SASOL NORTH AMERICA
BALTIMORE, MARYLAND



LEGEND

- PROPERTY LINE
- RAILROAD
- FORMER ACID SEWER (REMOVED 1990)
- MONITORING WELL LOCATION
- 2 — GROUND WATER CONTOUR (FEET MSL) (DASHED WHERE INFERRED)
- 1.93 — GROUND WATER ELEVATION (FEET MSL)
- GROUND WATER FLOW DIRECTION

500 250 0 500

SCALE IN FEET

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Figure 6
Modeled Distribution of Benzene Between Slip Water and Atmosphere

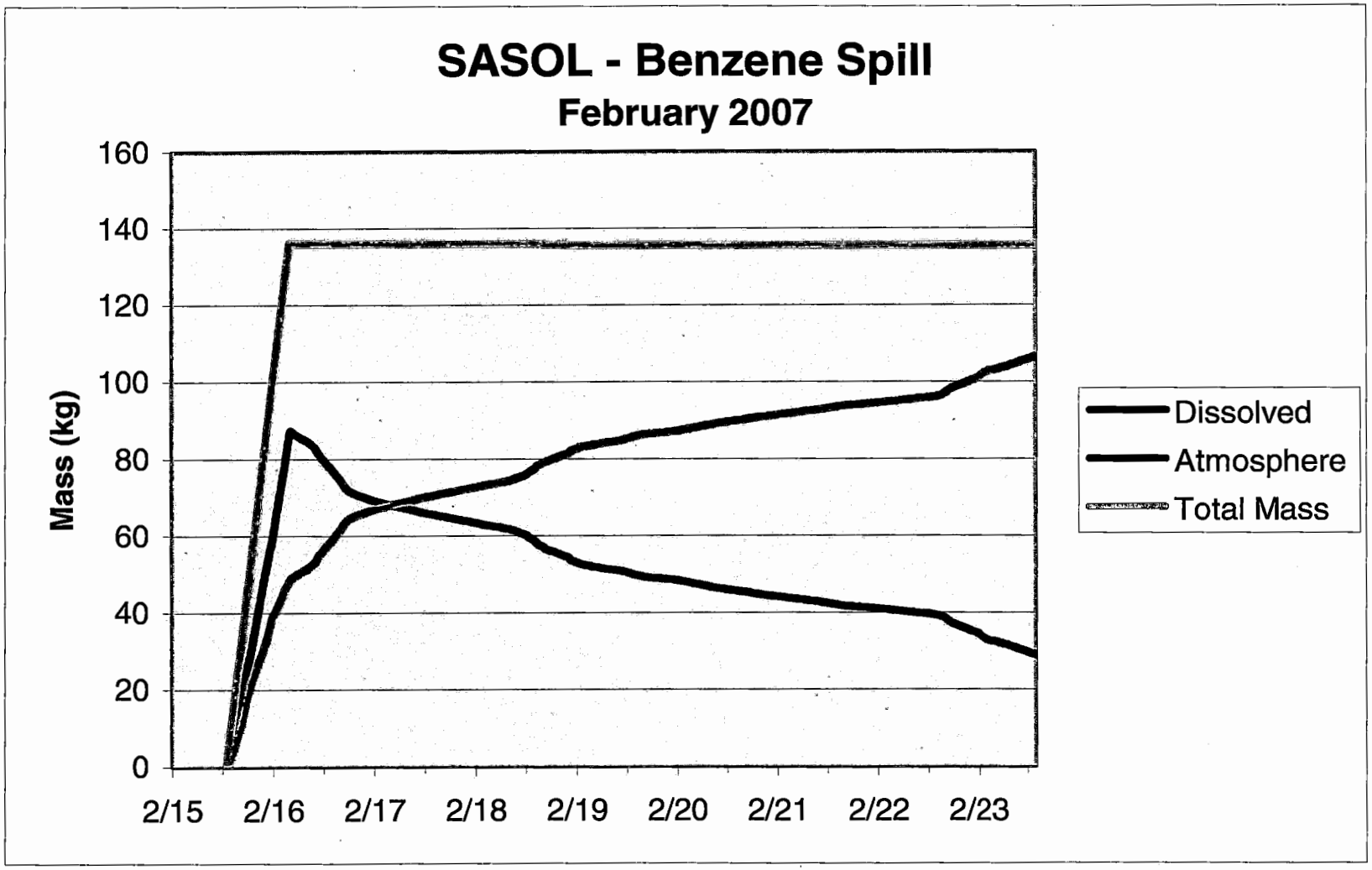


Figure 7
Locations for Modeled Benzene Concentrations

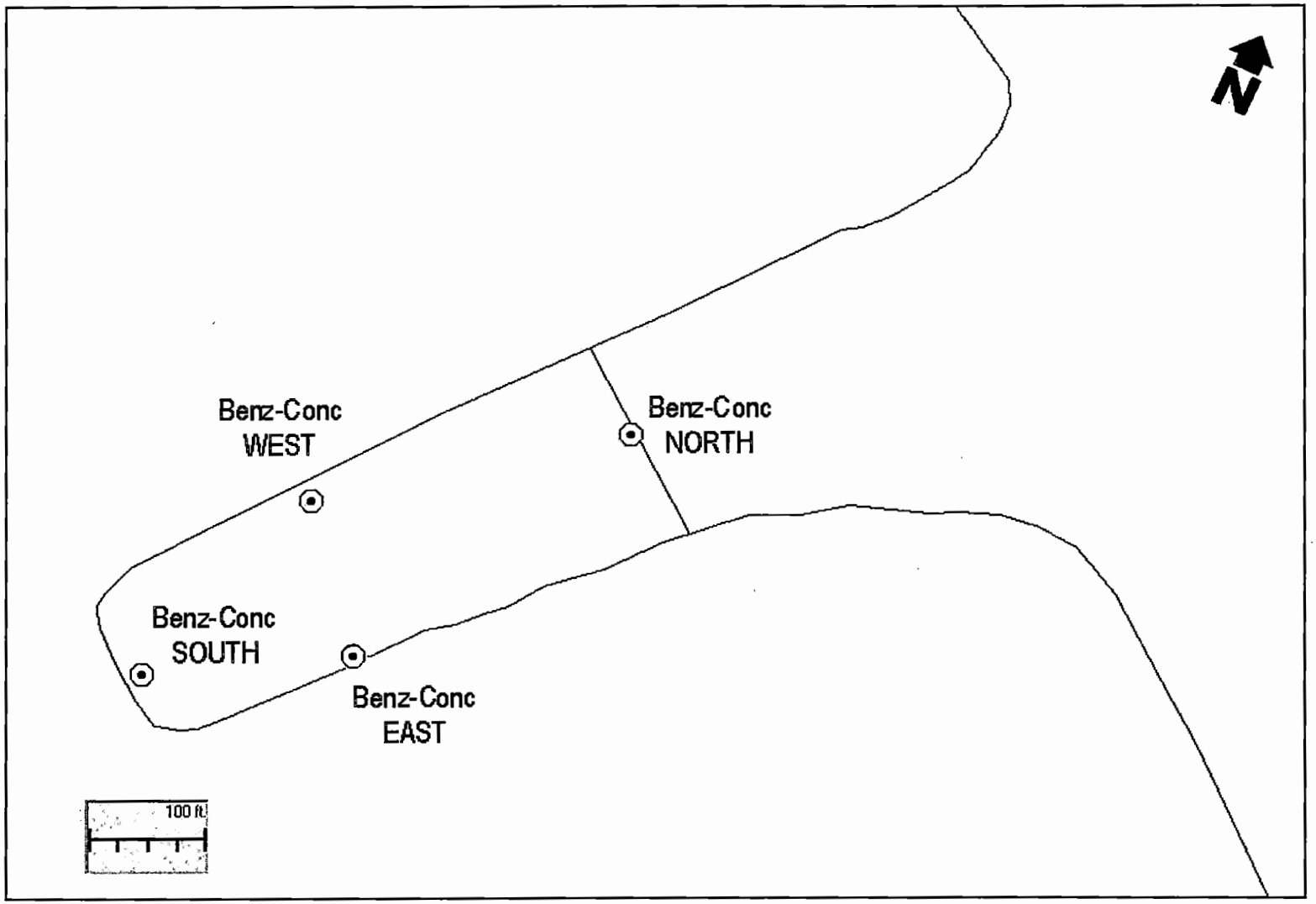
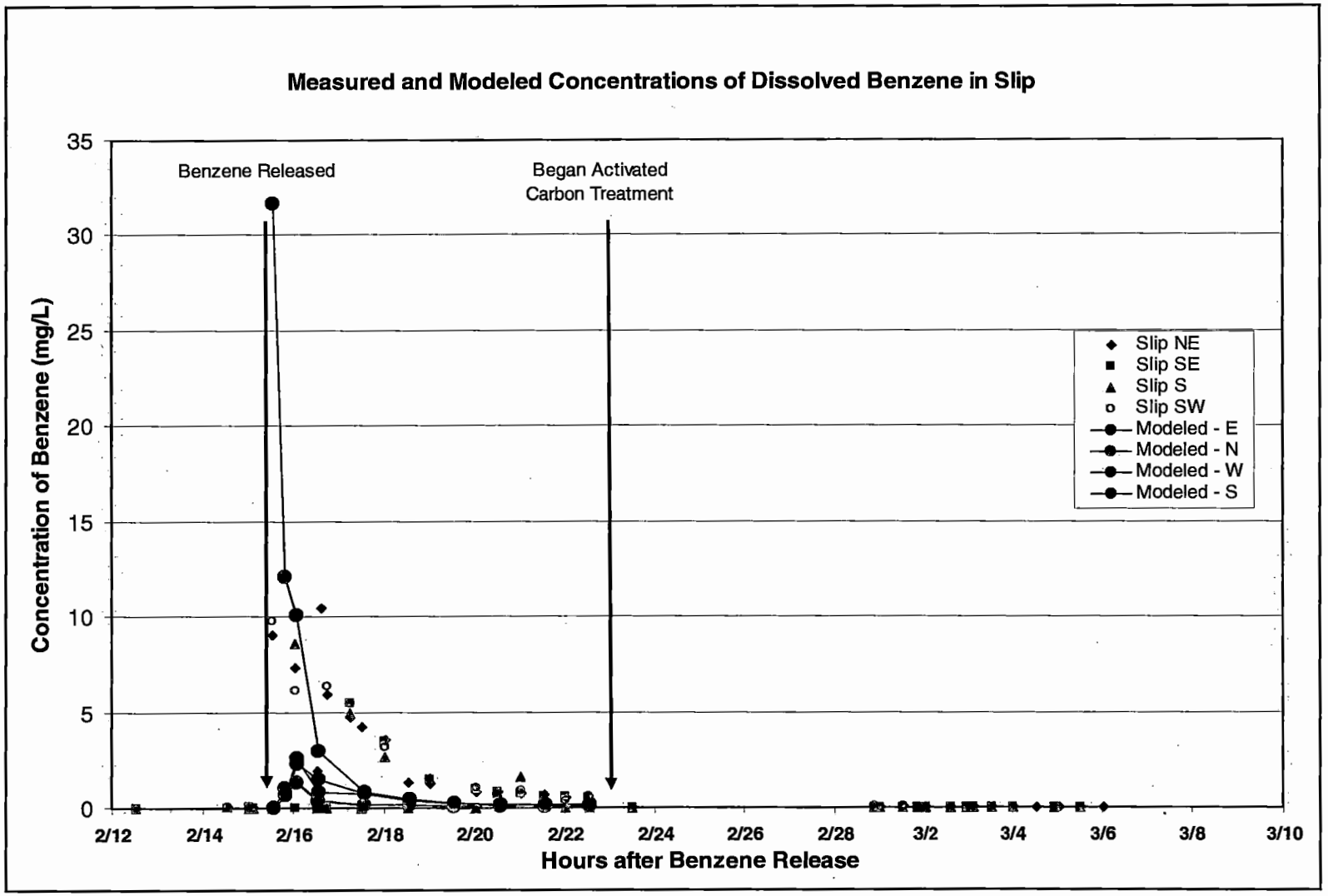


Figure 8
Modeled Benzene Concentrations vs. Observed Benzene Concentrations



TABLES

Table 1 Release Timeline and Benzene Concentrations in Slip Surface Water
Sasol North America, Baltimore, Maryland

Sample Date	Sample Time	Sample Location	Slip N	Slip NE	Slip SE	Slip S	Slip SW	Slip NW
2/12/07	23:00		---	ND	---	---	---	---
2/13/07	11:00		---	ND	---	---	---	---
2/14/07	11:00		---	63	---	71	51	---
2/15/07	11:00		---	43	44	---	27	---
	13:00		Benzene Release (between 13:00 2/15/07 and 04:00 2/16/07)					
2/16/07	11:00		---	9,035	---	---	9,782	---
	23:00		---	7,369	---	8,628	6,138	---
2/17/07	11:00		---	1,939	---	---	---	---
	12:00		Begin Continuous Agitation of Slip					
	13:27		---	10,488	---	---	---	---
	16:47		---	5,951/4,959	---	---	6,404	5,783
2/18/07	02:35		---	4,727	5,487	4,947	5,455	---
	11:00		---	4,223	---	---	---	---
	23:00		---	3,531	3,495	2,703	3,224	---
2/19/07	11:00		---	1,330	---	---	---	---
	23:00		---	1,286	1,462	1,527	1,476	---
2/20/07	23:00		---	849	976	---	1,048	---
2/21/07	11:00		---	835	826	797	711	---
	23:00		---	729	763	1,609	924	---
2/22/07	11:00		---	638	580	578	568	---
	23:00		---	517	612	---	402	---
2/23/07	11:00		---	612	542	564	616	---
	12:00		Begin Treatment of Slip Water With Activated Carbon					
2/24/07	11:00		---	3	---	---	---	---
3/1/07	19:19		---	---	3	3	78	---
	23:00		---	4	---	---	---	---
3/2/07	10:22		---	---	12	---	82	---
	11:00		---	39	---	---	---	---
	18:49		---	---	2	1	1	---
	23:00		---	1	---	---	---	---
3/3/07	12:56		ND	1	ND	---	1	---
	19:27		---	---	3	3	3	---
	23:00		---	4	---	---	---	---
3/4/07	09:22		3	3	2	---	2	---
	20:20		---	1	1	ND	ND	---
3/5/07	11:00		---	ND	---	---	---	---
	21:06		---	---	ND	ND	ND	---
	23:00		---	ND	---	---	---	---
3/6/07	11:00		---	ND	ND	ND	ND	---
	19:12		---	---	---	---	---	---
	23:00		---	ND	---	---	---	---
3/9/07	---		End Treatment of Slip Water With Activated Carbon					

Notes:
ND - not detected
--- No sample collected from this location at this time.
Benzene concentrations were measured by plant laboratory.

Table 2 Analytical Results for Slip Surface Water Samples - November 2007
Sasol North America, Baltimore, Maryland

Sample ID	SW-1	SW-2	SW-3 (Dup. of SW-1)
Date Sampled	11/12/2007	11/12/2007	11/12/2007
VOCs (ug/L)			
Benzene	ND <1	ND <1	ND <1
Ethylbenzene	ND <1	ND <1	ND <1
Toluene	ND <1	ND <1	ND <1
m,p-Xylenes	ND <2	ND <2	ND <2
o-Xylenes	ND <1	ND <1	ND <1
Natural Attenuation Parameters (mg/L)			
Total Alkalinity	68	70	-
Chloride	140	140	-
Dissolved Iron	ND <100	ND <100	-
Methane	0.0057	ND <0.0059	-
Sulfate	67	67	-
Total Organic Carbon	1.5	2.1	-
Total Suspended Solids	5	4	-

Notes:
ND < - Not detected, value indicates detection limit
- - Not analyzed for this parameter

Table 3 Analytical Results for Slip Sediment Samples
Sasol North America, Baltimore, Maryland

Parameter	EPA Region III RCRA-Regulated Waste Concentration Limit	Location ID:	SED-1		SED-2			SED-3			SED-4		
		Sample Type:	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab
		Sampled By:	ERM	ERM	ERM	ERM	ERM	ERM	ERM	ERM	ERM	ERM	ERM
		Sample Date:	8/15/06	4/9/07	8/15/06	4/9/07	11/12/2007	8/15/06	4/9/07	11/12/2007	8/15/06	4/9/07	11/12/2007
TCLP VOCs (ug/l)													
Benzene	500		ND <20	ND <20	**280**	ND <20	--	ND <20	ND <20	--	ND <20	ND <20	--
TCLP SVOCs (ug/l)													
None Detected	NA		ND	ND	ND	ND	--	ND	ND	--	ND	ND	--
TCLP Herbicides (ug/l)													
None Detected	NA		ND	ND	ND	ND	--	ND	ND	--	ND	ND	--
TCLP Pesticides (ug/l)													
None Detected	NA		ND	ND	ND	ND	--	ND	ND	--	ND	ND	--
TCLP Inorganics (Metals) (mg/l)													
None Detected	NA		ND	ND	ND	ND	--	ND	ND	--	ND	ND	--
Purgeable Aromatics (ug/kg)													
Benzene	NA		ND <8	ND <28	**5,200**	**66 J**	**2,900**	ND <8	**62**	ND <23	ND <6	**40**	**23**
Ethylbenzene			ND <8	ND <28	ND <110	ND <39	**360**	ND <8	ND <46	ND <23	ND <6	ND <36	**31**
Toluene			ND <8	ND <28	ND <110	ND <39	**44**	ND <8	ND <46	ND <23	ND <6	ND <36	ND <19
m,p-Xylenes			ND <17	ND <57	ND <220	ND <78	**720**	ND <16	ND <92	**51**	ND <12	ND <73	**120**
o-Xylenes			ND <8	ND <28	ND <110	ND <39	**190**	ND <8	ND <46	ND <23	ND <6	ND <36	**67**
Flash Point (°F)													
Flash Point	<140 °F		>140 °F	>140 °F	>140 °F	>140 °F	--	>140 °F	>140 °F	--	>140 °F	>140 °F	--
Corrosivity (pH)													
pH	<2 or >12		**7.4**	**7.1**	**7.3**	**7.2**	--	**7.4**	**7.6**	--	**7.2**	**8.3**	--
Reactivity (CNs and Ss) (mg/kg)													
Cyanides, releasable HCN	250		ND <0.36	ND <0.5	ND <0.51	ND <0.5	--	ND <0.27	ND <0.5	--	ND <0.32	ND <0.5	--
Sulfides, releasable H2S	500		ND <72	ND <1.0	ND <100	ND <1.0	--	**150**	ND <1.0	--	**76**	ND <1.0	--

NOTES:
BTEX - Benzene, Toluene, Ethylbenzene, and Xylenes
NA - Not Applicable.
ND - Not Detected, value indicates reporting limit.
-- - Sample was not analyzed for this parameter
J - Estimated result
TCLP - Toxicity Characteristic Leaching Procedure

VOCs - Volatile Organic Compounds
SVOCs - Semi-Volatile Organic Compounds
mg/L - milligrams per liter
ug/L - micrograms per liter
mg/kg - milligrams per kilogram
ug/kg - micrograms per kilogram

Table 3 Analytical Results for Slip Sediment Samples
Sasol North America, Baltimore, Maryland

Parameter	EPA Region III RCRA-Regulated Waste Concentration Limit	Location ID:	SED-7			SED-5		SED-6		
		Sample Type:	Duplicate of SED-4			Grab	Grab	Grab	Grab	Grab
		Sampled By:	ERM	ERM	ERM	ERM	ERM	ERM	ERM	ERM
		Sample Date:	8/15/06	4/9/07	11/12/2007	8/15/06	4/9/07	8/15/06	4/9/07	11/12/2007
TCLP VOCs (ug/l)										
Benzene	500		–	–	–	ND <20	ND <20	ND <20	ND <20	–
TCLP SVOCs (ug/l)										
None Detected	NA		–	–	–	ND	ND	ND	ND	–
TCLP Herbicides (ug/l)										
None Detected	NA		–	–	–	ND	ND	ND	ND	–
TCLP Pesticides (ug/l)										
None Detected	NA		–	–	–	ND	ND	ND	ND	—
TCLP Inorganics (Metals) (mg/l)										
None Detected	NA		–	–	–	ND	ND	ND	ND	–
Purgeable Aromatics (ug/kg)										
Benzene	NA		ND <7	ND <1 J	ND <21	ND <130	ND <38	ND <11 L	ND <36	ND <28
Ethylbenzene			ND <7	ND <1	**22**	ND <130	ND <38	ND <11	ND <36	**34**
Toluene			ND <7	ND <1	ND <21	ND <130	ND <38	ND <11	ND <36	ND <28
m,p-Xylenes			ND <14	ND <2	**120**	ND <260	ND <76	ND <22	ND <72	**82**
o-Xylenes			ND <7	ND <1	**88**	ND <130	ND <38	ND <11	ND <72	**73**
Flash Point (°F)										
Flash Point	<140 °F		–	–	–	>140 °F	>140 °F	>140 °F	>140 °F	–
Corrosivity (pH)										
pH	<2 or >12		–	–	–	**7.4**	**7.1**	**7.5**	**7.5**	–
Reactivity (CNs and Ss) (mg/kg)										
Cyanides, releasable HCN	250		–	–	–	ND <0.42	ND <0.5	ND <0.49	< 0.5	–
Sulfides, releasable H2S	500		–	–	–	**130**	ND <1.0	**350**	ND <1.0	–

NOTES:
BTEX - Benzene, Toluene, Ethylbenzene, and Xylenes
NA - Not Applicable.
ND - Not Detected, value indicates reporting limit.
– - Sample was not analyzed for this parameter
J - Estimated result
TCLP - Toxicity Characteristic Leaching Proceture

VOCs - Volatile Organic Compounds
SVOCs - Semi-Volatile Organic Compounds
mg/L - milligrams per liter
ug/L - micrograms per liter
mg/kg - milligrams per kilogram
ug/kg - micrograms per kilogram

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-05I											
			11/29/88	3/28/91	3/9/95	5/26/95	9/25/95	12/15/95	9/10/96	4/3/97	9/25/97	3/24/98	6/27/01	12/6/01
VOCs (µg/L)														
Benzene	5		13,000	3,150	< 5	< 5	< 5	< 5	0.1 J	0.3 J	0.1 J	0.6 J	10	2
Ethylbenzene	700		< 500	< 180	< 5	< 5	< 5	< 5	< 1	< 1	0.12 J	< 1	< 2	< 1
Toluene	1,000		< 500	< 150	< 5	< 5	< 5	< 5	< 1	< 1	0.08 J	< 1	< 2	< 1
Xylenes	10,000		-	-	< 5	< 5	< 5	< 5	< 3	< 3	0.8 J	1.1 J	< 2	1
MTBE	20		-	-	-	-	-	-	-	-	-	-	< 2	< 1
Chlorobenzene	11		<500	< 150	< 5	< 5	< 5	< 5	-	-	-	-	40	17
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		139	-	-	-	-	-	-	-	-	-	223	223
Chloride (mg/L)	no standard		9,690	-	-	-	-	-	-	-	-	-	6	2,106
Dissolved Iron (mg/L)	0.3		-	-	-	-	-	-	35	22	37	21	28	32
Methane (mg/L)	no standard		-	-	-	-	-	-	1.0	0.9	4.5	1.0	0.4	0.3
Sulfate (mg/L)	no standard		< 2	-	-	-	-	-	< 2	< 2	< 2	< 2	< 1	< 1
Field Parameters														
pH	no standard		-	-	-	-	-	7.20	7.16	6.92	7.16	7.22	7.25	7.38
Specific Conductance (µS/cm)	no standard		-	-	-	-	-	7,450	1,608	6,940	-	6,520	3,590	6,300
Temperature (°C)	no standard		-	-	-	-	-	14.9	19.2	16.9	18.2	15.5	16.3	16.9
ORP (mV)	no standard		-	-	-	-	-	-3.4	-171.9	27.7	-123.2	-20.4	-191.0	-146.4
Dissolved Oxygen (mg/L)	no standard		-	-	-	-	-	2.1	0.1	1.9	0.69	0.62	2.73	0.17

Notes:

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- J - Estimated result. Result is less than the reporting limit.
- e - Estimated result. Result is higher than the reporitng limit.
- B - Parameter detected at similar level in blank
- d - elevated reporting limit due to sample dilution

µS/cm - microseimens per centimeter
°C - degrees Celcius
mV - millivolts
mg/L - milligrams per liter
µg/L - micrograms per liter
VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-05I (Cont.) 5/30/02	11/26/02	5/19/03	11/21/03	5/21/04	11/22/04	5/18/05	11/22/05	5/25/06	11/28/06	5/10/07	11/29/07
VOCs (µg/L)														
Benzene	5		< 5	< 5	7	9	< 1	< 1	6	<1	5	<1	6	6
Ethylbenzene	700		< 5	< 5	< 1	<1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	<1
Toluene	1,000		< 5	< 5	< 1	1	<	1	< 1	< 1	< 1	< 1	< 1	<1
Xylenes	10,000		< 5	< 5	<.1	<1	2	<1	<1	<3	<3	<3	<3	<2
MTBE	20		9	10	7	13	7	8	5	5	7	10	14	16
Chlorobenzene	11		< 5	6	5	11	4	16	5	6	22	24	63	63
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		90	242	94	240	226	244	207	206	219	190	158	152
Chloride (mg/L)	no standard		1,900	1,396	1,400	2,000	1,030	1,110	1,120	1,040	982	960	670	1,000
Dissolved Iron (mg/L)	0.3		28	27	8	20	16	21	5	16	26	22	42	47
Methane (mg/L)	no standard		0.2	0.5	< 1	0.6	0.6	0.3	0.1	0.3	1.1	2.0	5.31	5.69
Sulfate (mg/L)	no standard		9	5	32	16	26	29	29	27	16	<50	<20	<20
Field Parameters														
pH	no standard		7.30	7.36	7.22	7.34	7.25	7.36	6.94	7.38	7.35	7.07	6.92	6.95
Specific Conductance (µS/cm)	no standard		7,370	5,640	6,310	4,730	3,900	4,060	3,745	3,199	3,434	3,196	3,850	3,698
Temperature (°C)	no standard		17.1	15.7	14.8	16.6	15.8	15.8	16.0	15.2	15.9	15.4	15.4	15.6
ORP (mV)	no standard		-135.7	-126.7	-118	-202	-191	NM	101.5	-193.9	-171.7	NM	-186	-205.8
Dissolved Oxygen (mg/L)	no standard		0.00	0.05	0.00	1.43	0.00	3.77	0.28	4.02	0.16	NM	0.30	0.18

Notes:

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B - Parameter detected at similar level in blank
d - elevated reporting limit due to sample dilution

µS/cm - microseimens per centimeter
°C - degrees Celcius
mV - millivolts
mg/L - milligrams per liter
µg/L - micrograms per liter
VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-05S 11/29/88	3/28/91	3/9/95	5/26/95	9/25/95	12/15/95	9/11/96	4/7/97	9/29/97	3/25/98	6/15/99	12/7/99
VOCs (µg/L)														
Benzene	5		5.4	5.04	14	11	37	12	6	38	0.98 J	5.1	1.0 J	ND
Ethylbenzene	700		< 5	< 7.2	ND	ND	ND	ND	0.3 J	0.35 J	0.24 J	0.3 J	0.2 J	0.2 J
Toluene	1,000		< 5	< 6.0	ND	ND	ND	ND	ND	0.12 J	0.09 J	ND	ND	ND
Xylenes	10,000		-	-	ND	ND	ND	ND	4.	4.5	4.9	7	5	-
MTBE	20		-	-	14	-	-	-	-	-	-	-	23	-
Chlorobenzene	11		< 5	< 6.0	ND	ND	ND	ND	-	-	-	-	ND	ND
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		500	-	-	-	-	-	-	-	-	-	-	-
Chloride (mg/L)	no standard		485	-	-	-	-	-	-	-	-	-	-	-
Dissolved Iron (mg/L)	0.3		-	-	-	-	-	-	-	-	-	-	-	-
Methane (mg/L)	no standard		-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (mg/L)	no standard		24	-	-	-	-	-	-	-	-	-	-	-
Field Parameters														
pH	no standard		-	-	-	-	-	7.34	7.40	6.96	6.97	7.00	6.99	7.03
Specific Conductance (µS/cm)	no standard		-	-	-	-	-	2,210	1,150	3,770	-	1,848	1,464	735
Temperature (°C)	no standard		-	-	-	-	-	15.5	18.1	15.7	18.3	14.6	15.2	18.1
ORP (mV)	no standard		-	-	-	-	-	-26.1	58.8	-104.6	-112.4	-81.3	-115.5	-118.5
Dissolved Oxygen (mg/L)	no standard		-	-	-	-	-	1.4	1.1	0.9	0.55	0.42	0.6	1.04

Notes:

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- e - Estimated result. Result is higher than the reporitng limit.
- B - Parameter detected at similar level in blank
- d - elevated reporting limit due to sample dilution

µS/cm - microseimens per centimeter
°C - degrees Celcius
mV - millivolts
mg/L - milligrams per liter
µg/L - micrograms per liter
VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-05S (Cont.)										MW-8S	
			6/22/00	12/5/00	6/27/01	5/29/02	5/19/03	5/21/04	5/18/05	5/25/06	5/9/07	11/29/07	11/29/88	3/28/91
VOCs (µg/L)														
Benzene	5		11	39	2	< 5	21	8	10	47	1	8	< 5	< 4.4
Ethylbenzene	700		4	< 10 d	6	< 5	5	5	< 1	< 1	< 1	<1	< 5	< 7.2
Toluene	1,000		< 2 d	< 10 d	< 2	< 5	< 1	< 1	<1	<1	2	<1	< 5	< 6
Xylenes	10,000		9	< 10 d	16	< 5	7	7	<1	<3	1	<2	-	-
MTBE	20		19	36	46	32	26	28	35	29	15	28	-	-
Chlorobenzene	11		14	13	23	< 5	3	3	<1	5	4	-	-	-
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		-	-	-	-	-	-	-	-	-	398	-	-
Chloride (mg/L)	no standard		-	-	-	-	-	-	-	-	-	270	53	-
Dissolved Iron (mg/L)	0.3		-	-	-	-	-	-	-	-	-	13	-	-
Methane (mg/L)	no standard		-	-	-	-	-	-	-	-	-	12	-	-
Sulfate (mg/L)	no standard		-	-	-	-	-	-	-	-	-	200	53	-
Field Parameters														
pH	no standard		6.68	7.32	6.87	6.91	7.06	6.88	6.62	7.15	7.03	6.84	-	-
Specific Conductance (µS/cm)	no standard		2,150	2,000	1,330	2,510	5,020	5,100	4,301	2,866	1,880	2,011	-	-
Temperature (°C)	no standard		19.5	14.2	14.7	16.4	15.9	16.6	14.4	15.1	15.6	16.8	-	-
ORP (mV)	no standard		-80.0	-96.8	-156.0	-122.5	-158	-176	-81.1	-178.9	-117	-174.8	-	-
Dissolved Oxygen (mg/L)	no standard		-	0.07	2.39	0.78	0.00	0.00	0.22	0.12	0.30	0.08	-	-

Notes:

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ND - Parameter not detected, detection limit not shown
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e - Estimated result. Result is higher than the reporitng limit.
B - Parameter detected at similar level in blank
d - elevated reporting limit due to sample dilution

µS/cm - microseimens per centimeter
°C - degrees Celcius
mV - millivolts
mg/L - milligrams per liter
µg/L - micrograms per liter
VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-8S (Cont.)										MW-8I	
			3/9/95	5/26/95	9/25/95	12/15/95	9/11/96	4/7/97	9/29/97	3/25/98	6/15/99	11/29/07	11/29/88	3/28/91
VOCs (µg/L)														
Benzene	5		1	< 1.7	< 1.7	< 1.7	< 0.1	0.07 J	< 0.04	< 0.2	0.4 J	9	< 5	< 4.4
Ethylbenzene	700		< 1	< 1.6	< 1.6	< 1.6	< 0.3	0.07 J	0.07 J	< 0.2	0.2 J	<1	< 5	< 7.2
Toluene	1,000		< 1	< 1.3	< 1.3	< 1.3	< 0.2	< 0.5	< 0.5	< 0.2	< 0.2	<1	< 5	< 6
Xylenes	10,000		< 1	< 3.2	< 3.2	< 3.2	< 0.9	0.12	< 0.07	< 0.6	< 0.6	<2	-	-
MTBE	20		-	-	-	-	-	-	-	-	12	2	-	-
Chlorobenzene	11		-	-	-	-	-	-	-	-	< 0.2	-	< 5	< 6
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		-	-	-	-	-	-	-	-	-	227	-	-
Chloride (mg/L)	no standard		64	-	21.9	-	-	-	-	-	-	46	420	-
Dissolved Iron (mg/L)	0.3		0.54	0.262	0.527	0.76	-	-	-	-	-	0.110	-	-
Methane (mg/L)	no standard		-	2.4	1.0	1.5	-	-	-	-	-	0.0151	-	-
Sulfate (mg/L)	no standard		70	-	12	-	-	-	-	-	-	64	12	-
Field Parameters														
pH	no standard		-	-	-	6.42	6.99	7.03	7.03	7.18	6.88	6.76	-	-
Specific Conductance (µS/cm)	no standard		-	-	-	10	318	1,564	1,208	628	775	648	-	-
Temperature (°C)	no standard		-	-	-	10.4	20.6	12.6	19.2	13.7	15.7	18.2	-	-
ORP (mV)	no standard		-	-	-	74.8	-12.5	-42.5	-85.2	-39.4	-126.8	-112.3	-	-
Dissolved Oxygen (mg/L)	no standard		-	-	-	3.2	0.2	1.0	0.55	3.6	0.1	0.01	-	-

Notes:

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- B - Parameter detected at similar level in blank
- d - elevated reporting limit due to sample dilution
- µS/cm - microseimens per centimeter
- °C - degrees Celcius
- mV - millivolts
- mg/L - milligrams per liter
- µg/L - micrograms per liter
- VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-8I (Cont.) 3/9/95	5/26/95	9/25/95	12/15/95	9/11/96	4/7/97	9/29/97	3/25/98	6/15/99	11/29/07	MW-17I 3/28/91	4/11/91
VOCs (µg/L)														
Benzene	5		< 1	< 1.7	< 1.7	< 1.7	< 0.1	< 0.2	< 0.04	< 0.2	< 0.2	2	2,610	13,100
Ethylbenzene	700		< 1	< 1.6	< 1.6	< 1.6	< 0.3	< 0.2	< 0.05	< 0.2	< 0.2	<1	< 180	< 360
Toluene	1,000		< 1	< 1.3	< 1.3	< 1.3	< 0.2	< 0.2	< 0.05	< 0.2	< 0.2	<1	< 150	< 300
Xylenes	10,000		< 1	< 3.2	< 3.2	< 3.2	< 0.9	< 0.6	< 0.07	< 0.6	< 0.6	<2	-	-
MTBE	20		-	-	-	-	-	-	-	-	< 0.2	<1	-	-
Chlorobenzene	11		< 1	< 1.5	< 1.5	< 1.5	-	-	-	-	< 0.2	-	< 150	< 300
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		-	-	-	-	-	-	-	-	-	23	280	220
Chloride (mg/L)	no standard		1,100	-	843	-	-	-	-	-	738	1,100	5,465	994
Dissolved Iron (mg/L)	0.3		< 0.045	1.82	1.5	12.5	12.7	14.3	13.7	14.1	3.61	2.70	-	-
Methane (mg/L)	no standard		-	0.0099	0.007	0.027	0.028	0.031	0.029	0.039	0.092	0.0885	-	-
Sulfate (mg/L)	no standard		72	-	191	27	24	27.4	25.6	25.5	149	440	35	21
Field Parameters														
pH	no standard		-	-	-	5.90	6.50	6.38	6.41	5.72	5.72	5.13	-	-
Specific Conductance (µS/cm)	no standard		-	-	-	1,527	1,149	5,790	5,760	5,760	1,927	4,097	-	-
Temperature (°C)	no standard		-	-	-	12.0	17.2	16.7	16.3	15.0	16.7	16.1	-	-
ORP (mV)	no standard		-	-	-	120.5	-52.2	59.5	215.5	28.8	47.6	141.4	-	-
Dissolved Oxygen (mg/L)	no standard		5.4	2.6	3.9	2.9	0.0	2.4	0.29	0.38	0.5	0.33	-	-

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mV - millivolts
mg/L - milligrams per liter
µg/L - micrograms per liter
VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-17I (Cont.)										
			12/7/92	3/7/95	5/31/95	9/26/95	12/19/95	9/10/96	4/4/97	9/26/97	3/25/98	6/16/99	12/7/99
VOCs (µg/L)													
Benzene	5		1,380	2700 D	560	200	200	240	61	41	11	0.5 J	3
Ethylbenzene	700		< 72	2 J	ND	ND	ND	0.65 J	ND	0.18 J	ND	ND	ND
Toluene	1,000		< 60	2 J	ND	ND	ND	0.13 J	ND	0.13 J	ND	ND	ND
Xylenes	10,000		-	34	ND	5.2 J	6.2	7	6	5.9	5	3	-
MTBE	20		-	-	ND	-	-	-	-	-	-	35	-
Chlorobenzene	11		< 60	10	ND	4.2 J	6.5	-	-	-	-	6.5	7.2
Nat. Attenuation Indicators													
Alkalinity (mg/L as $CaCO_3$)	no standard		250	-	-	237	-	-	-	-	-	-	-
Chloride (mg/L)	no standard		3,450	3,600	-	3,840	-	-	-	-	-	1,710	1,750
Dissolved Iron (mg/L)	0.3		-	25	68	37	34	22	24	21	17	15	13
Methane (mg/L)	no standard		-	-	13.0	4.0	6.0	4.5	10.0	10.0	3.7	6.0	6.2
Sulfate (mg/L)	no standard		54	4	-	62	-	< 2	< 2	< 2	< 2	< 2	< 2
Field Parameters													
pH	no standard		-	-	-	-	6.89	7.19	7.22	7.26	7.34	7.71	7.59
Specific Conductance (µS/cm)	no standard		-	-	-	-	1,430	886	8,480	-	6,020	4,900	1,227
Temperature (°C)	no standard		-	-	-	-	13.5	16.7	15.9	16.4	16.3	16.2	15.4
ORP (mV)	no standard		-	-	-	-	10.1	-168.4	-149.0	-133.4	-97.4	-191.5	-154.5
Dissolved Oxygen (mg/L)	no standard		-	-	-	-	2.3	2.0	1.1	0.59	3.43	0.6	0.88

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µS/cm - microseimens per centimeter
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mV - millivolts
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VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	MW-17I (Cont.)										P93-4	
			6/26/00	12/6/00	6/27/01	5/30/02	5/19/03	5/21/04	5/18/05	5/25/06	5/10/07	11/28/07	3/9/95	5/25/95
VOCs (µg/L)														
Benzene	5		3	< 5 d	2	3	3	< 1	< 1	2	<1	<1	9,400 D	7,500
Ethylbenzene	700		< 2 d	< 5 d	< 2	< 1	< 1	< 1	< 1	< 1	< 1	<1	40	70 J
Toluene	1,000		3	< 5 d	12	2	< 1	< 1	< 1	< 1	4	<1	8	ND
Xylenes	10,000		8	< 5 d	< 2	< 1	2	< 1	< 1	<3	5	<2	10	ND
MTBE	20		36	25	32	16	12	14	15	14	3	1	-	-
Chlorobenzene	11		10	9	12	2	6	5	5	7	15	-	16	ND
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		241	257	-	-	-	-	7	-	-	179	-	-
Chloride (mg/L)	no standard		1,100	1,548	-	-	-	-	4	-	-	1,300	-	-
Dissolved Iron (mg/L)	0.3		14	13	-	-	-	-	16	-	-	45	-	-
Methane (mg/L)	no standard		9.8	7.6	-	-	-	-	-163.0	-	-	0.203	-	-
Sulfate (mg/L)	no standard		2	< 5	-	-	-	-	0	-	-	250	-	-
Field Parameters														
pH	no standard		7.28	8.05	7.53	7.81	7.81	7.58	7.28	7.60	7.19	6.95	-	-
Specific Conductance (µS/cm)	no standard		5,260	5,020	2,820	4,520	4,420	3,900	3,633	3,755	4,810	4,772	-	-
Temperature (°C)	no standard		24.5	13.2	16.4	16.9	16.0	17.5	15.7	17.9	15.4	14.6	-	-
ORP (mV)	no standard		-	-118.5	-220.0	-154.5	-235.0	-221	-163	-183.4	-199	-76.1	-	-
Dissolved Oxygen (mg/L)	no standard		-	0.76	1.32	0.00	0.00	0.00	0.22	0.48	0.20	0.28	-	-

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µS/cm - microseimens per centimeter

°C - degrees Celcius

mV - millivolts

mg/L - milligrams per liter

µg/L - micrograms per liter

VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	P93-4 (Cont.)											
			9/29/95	12/22/95	9/11/96	4/7/97	9/29/97	3/26/98	3/26/98	6/16/99	12/7/99	6/26/00	12/6/00	6/27/01
VOCs (µg/L)														
Benzene	5		1,400	13,000	2,200	1,600	5,700	5,400	5,300	2,200	2,200	1,500	430	1,100
Ethylbenzene	700		24 J	73	24	19	44 J	33 J	33 J	13 J	17 J	17	8	13
Toluene	1,000		2.5 J	22 J	8	3.0 J	11 J	ND	ND	11 J	ND	4	2	< 2
Xylenes	10,000		ND	ND	10	3.1 J	13 J	< 60	< 60	< 30	-	10	4	7
MTBE	20		-	-	-	-	-	-	-	< 10	-	< 2 d	< 1	< 2
Chlorobenzene	11		8.2 J	29 J	-	-	-	-	-	12 J	13 J	16	13	20
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		-	-	-	-	-	-	-	-	-	41	40	-
Chloride (mg/L)	no standard		-	-	-	-	-	-	-	8,690	8,540	518	1,908	-
Dissolved Iron (mg/L)	0.3		-	-	306	372	359	347	332	382	397	24	392	-
Methane (mg/L)	no standard		-	-	1.5	3.1	4.5	1.6	1.7	3.0	3.8	4.8	3.2	-
Sulfate (mg/L)	no standard		-	-	180	187	168	154	128	137	145	50	90	-
Field Parameters														
pH	no standard		-	6.16	6.00	5.78	5.79	5.91	5.92	5.76	5.87	5.55	5.92	5.74
Specific Conductance (µS/cm)	no standard		-	1,063	8,940	19,570	21,900	20,400	20,500	14,100	2,420	23,300	23,100	20,300
Temperature (°C)	no standard		-	12.3	18.5	18.4	18.4	17.7	17.7	18.6	17.6	22.1	12.8	16.7
ORP (mV)	no standard		-	64.9	67.5	-34	-58.2	79.8	80.1	12.5	-9.0	-	2.1	-37.0
Dissolved Oxygen (mg/L)	no standard		-	2.2	1.1	1.4	0.9	3.99	3.96	0.6	0.81	-	0.38	1.76

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µS/cm - microseimens per centimeter
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VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	P93-4 (Cont)								P93-5			
			5/30/02	5/19/03	5/20/04	5/19/05	5/24/06	5/9/07	11/29/07	11/29/07 dup	6/29/01	5/29/02	5/19/03	5/21/04
VOCs (µg/L)														
Benzene	5		64	140	21	16	4	34	10	8	39	< 5	1,000	450
Ethylbenzene	700		< 5	2	1	<1	<1	<1	<1	<1	< 2	< 5	140	64
Toluene	1,000		13	< 1	< 1	<1	<1	2	<1	<1	< 2	< 5	200	94
Xylenes	10,000		< 5	< 1	< 1	<1	<3	<3	<2	<2	2	< 5	400	180
MTBE	20		< 5	2	< 1	<1	<1	<1	<1	<1	< 2	16	56	35
Chlorobenzene	11		11	12	9	8	3	15	-	-	3	< 5	6	3
Nat. Attenuation Indicators														
Alkalinity (mg/L as $CaCO_3$)	no standard		-	-	-	5	-	-	97	-	-	-	-	-
Chloride (mg/L)	no standard		-	-	-	21	-	-	6,900	-	-	-	-	-
Dissolved Iron (mg/L)	0.3		-	-	-	16	-	-	240	-	-	-	-	-
Methane (mg/L)	no standard		-	-	-	46.5	-	-	0.924	-	-	-	-	-
Sulfate (mg/L)	no standard		-	-	-	0	-	-	400	-	-	-	-	-
Field Parameters														
pH	no standard		5.76	5.83	5.70	5.45	5.86	5.82	5.96	-	7.62	7.70	9.25	9.24
Specific Conductance (µS/cm)	no standard		32,700	27,800	22,000	20,920	21,870	1,965	18,270	-	1,290	2,420	793	720
Temperature (°C)	no standard		16.9	17.6	17.0	16.2	17.0	15.9	16.51	-	15.9	15.8	17.2	16.5
ORP (mV)	no standard		-33.4	-16.0	-41.0	46.5	-20.4	6.0	-104.2	-	-258.0	-120.1	-406	-402
Dissolved Oxygen (mg/L)	no standard		0.80	0.00	0.00	0.40	1.03	0.40	0.16	-	4.15	0.00	0.00	0.00

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°C - degrees Celcius
mV - millivolts
mg/L - milligrams per liter
µg/L - micrograms per liter
VOCs - Volatile Organic Compounds

Table 4

Analytical Results for Slip Area Ground Water Samples

Sasol North America, Baltimore, Maryland

Well ID / Date Sampled	MDE Ground Water Cleanup Standard	Well ID / Sample Date	P93-5 (Cont) 5/19/05	5/25/06	5/9/07	11/28/07
VOCs (µg/L)						
Benzene	5		650	160	130	<1
Ethylbenzene	700		160	6	2	<1
Toluene	1,000		89	6	<1	<1
Xylenes	10,000		280	8	<3	<2
MTBE	20		17	4	8	8
Chlorobenzene	11		<10	3	<1	-
Nat. Attenuation Indicators						
Alkalinity (mg/L as $CaCO_3$)	no standard		-	-	-	200
Chloride (mg/L)	no standard		-	-	-	20
Dissolved Iron (mg/L)	0.3		-	-	-	<100
Methane (mg/L)	no standard		-	-	-	7.56
Sulfate (mg/L)	no standard		-	-	-	74
Field Parameters						
pH	no standard		9.32	7.66	7.07	7.36
Specific Conductance (µS/cm)	no standard		567	795	779	634
Temperature (°C)	no standard		15.8	16.1	14.9	18.0
ORP (mV)	no standard		-332.4	296.4	-320	-348.7
Dissolved Oxygen (mg/L)	no standard		0.24	0.01	0.10	0.0

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APPENDICES

APPENDIX A
SURFACE WATER MODELING REPORT

Modeling of February 2007 Benzene Spill

Sasol North America, Baltimore Facility

16 January 2008

Environmental Resources Management

Delivering sustainable solutions in a more competitive world.

ERM

Contents

1. *SUMMARY*

Environmental Resources Management, Inc. (ERM) modeled the release of 300 lbs. of dissolved benzene which was discharged in untreated wastewater into the Slip at the Sasol Baltimore Facility on February 15, 2007 at approximately 13:00. The wastewater (120,000 gallons) was modeled as a uniform discharge over the course of 15 hours (i.e. 8000 gallons/hour). The spill was contained by sheet piling which prevented the contaminants from leaving the facility and entering the Patapsco River. Measured concentrations of benzene in the slip decreased from approximately 10 mg/L to 1 mg/L over 8 days before carbon treatment was applied on February 23, 2007. The cause of this decrease in concentration is the subject of this study.

2. *APPROACH*

Environmental Resources Management, Inc. (ERM) modeled the release of benzene into the Sasol Slip using a three-dimensional hydrodynamic and transport model. The model domain consists entirely of the Slip area.

ERM utilized the 3-D hydrodynamic and transport model GEMSS® ("Generalized Environmental Modeling System for Surfacewaters") for this study. GEMSS is an integrated system of 3-D hydrodynamic and transport models embedded in a geographic information and environmental data system. The model is non-proprietary, and the source code is available from the model developers. GEMSS allows transient simulations that can incorporate the varying meteorological, hydrological, and plant operational conditions.

This model has been used in many applications to determine the distribution of constituents due to various discharges. Besides computing detailed currents, temperatures, and temperature rises, the model has been generalized to compute entrainment of organisms; nutrient cycles; and the distribution of sediment, toxics, and oil spills. For application to Sasol, GEMSS required connection to its spill module, COSIM ("Chemical / Oil Spill Impact Module"). COSIM has been used on several major oil spills including the 1999 M/V Stuyvesant oil spill in Humboldt Bay, California, the 2000 Pepco oil spill on the Patuxent River, Maryland, and the 2003 Buzzards Bay spill in Massachusetts.

The intent of the study was to examine the fate of benzene after entering into the Slip, and compare changes in concentration against the observed values to assess the likely means through which the concentrations decreased.

3. *MODEL INPUTS*

Model inputs included the following: dimensions of the Slip, bathymetry, water surface elevation, hourly meteorological data, total suspended solids, and salinity. Hourly water temperatures were estimated using the meteorological data. The benzene discharge was characterized using inputs to describe the release time, mass, duration, location, flow rate, depth, and the physical and chemical properties of benzene.

3.1. *BATHYMETRIC AND SHORELINE DATA*

Dimensions of the Slip were obtained from AutoCAD drawings, drawn to scale, available from previous work at the facility. The model domain consists of a water surface approximately 450 ft across in the southwest to northeast direction, by 125 ft to 155 ft wide in the northwest to southeast direction. Bathymetric measurements, typically depths ranging between 9 ft. and 10 ft., were available from sediment sampling performed by ERM (1).

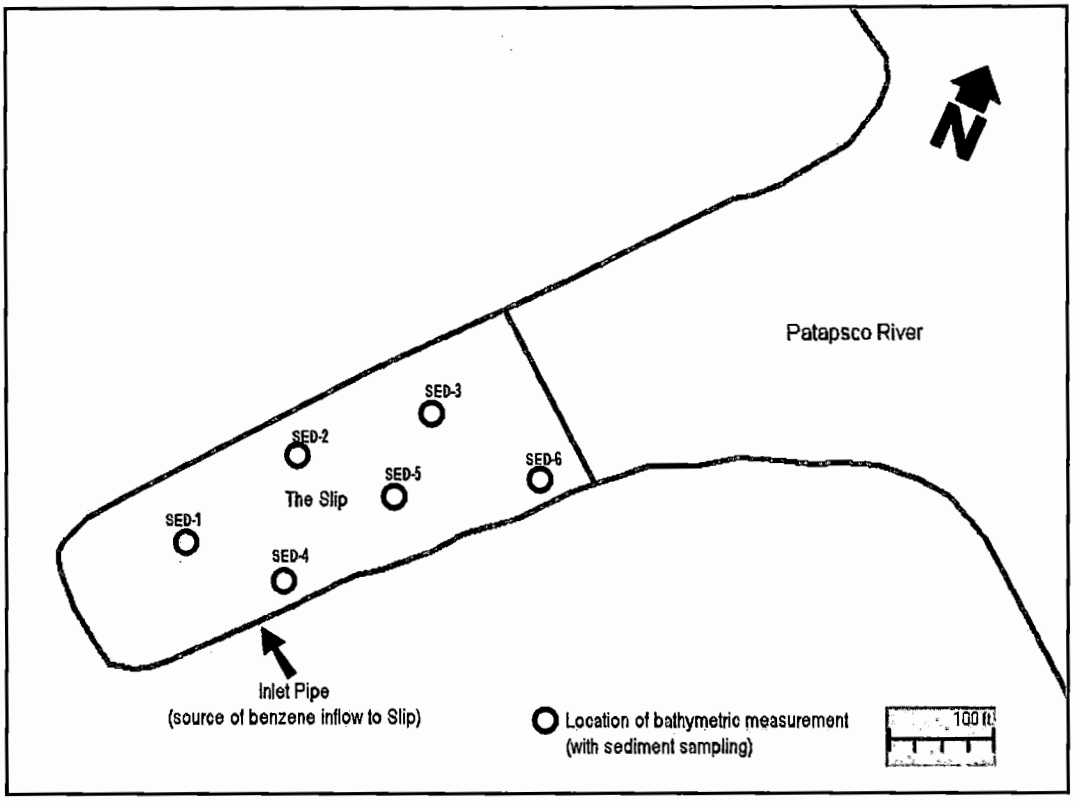

Figure 1 Location of bathymetric measurements and inlet pipe

3.2. *WATER SURFACE ELEVATION*

Water surface elevations (Figure 2) were measured at the facility and were used to account for variations of volume within the Slip resulting from precipitation, groundwater inflow and withdrawal, evaporation, and the wastewater flow received.

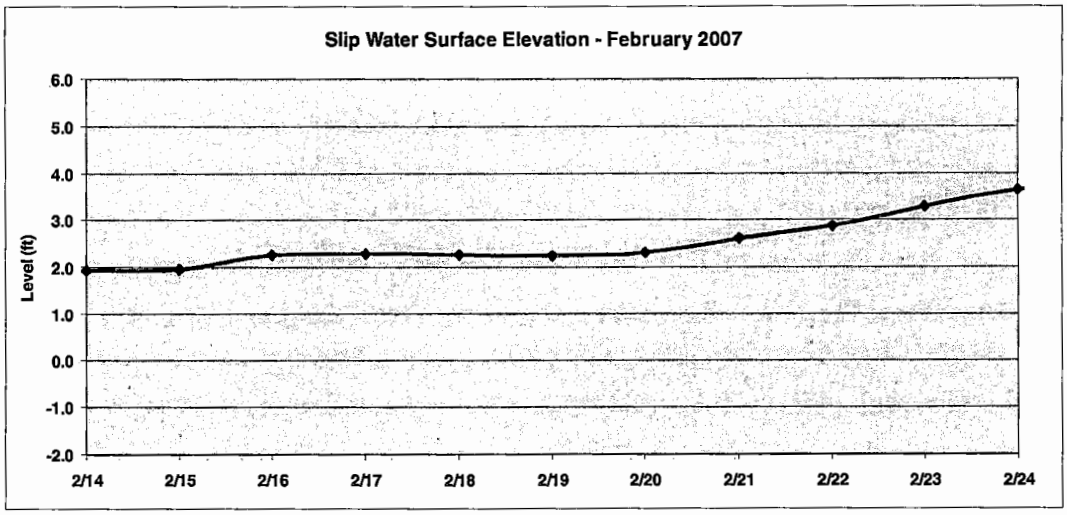

Figure 2 Water surface elevations

3.3. *METEOROLOGICAL DATA AND WATER TEMPERATURE ESTIMATES*

Detailed hourly meteorological data was acquired from the National Climatic Data Center's Automated Surface Observing System (ASOS) database for station KBWI at the Baltimore–Washington International Airport.

Water temperature was computed by the model using this meteorological data to estimate the water column's temperature in the absence of hourly measured water temperature data. The meteorological parameters that control surface heat exchange processes in the Slip can be summarized using the response temperature approach (Edinger, et al., 1974). The response temperature calculation uses the ASOS data, specifically air and dew point temperatures, wind speed, cloud cover, and atmospheric pressure to estimate water temperatures "responding" only to meteorological conditions.

3.4. *TOTAL SUSPENDED SOLIDS*

The wastewater's total suspended solids concentrations measured 4 mg/L and 5 mg/L in samples taken by ERM on 12 November, 2007. The model used a value of 5 mg/L as input.

3.5. *SALINITY*

The salinity within the slip was estimated at 6 ppt based on salinity profiles provided by Maryland's Department of Natural Resources (MDNR, 2008). The facility is located in a region with typical salinity ranging between 4 ppt and 8 ppt.

3.6. *BENZENE RELEASE CHARACTERISTICS*

The benzene was released from an inlet pipe located on the eastern side of the Slip (Figure X1). The input parameters describing the release are as follows:

Amount: 300 lbs of dissolved benzene

Wastewater flow: 8000 gal/hour

Duration: 15 hours

Start time: 15 February 2007, 13:00

Depth: surface release

The properties of benzene are as follows:

Boiling point: 80 C

Melting point: 5.5 C

Solubility at 25 C: 1790 mg/L

Molecular weight: 78.12 g/mole

Vapor pressure at 25 C: 12638.9 Pa

Density: 0.8765 gm/cc

(These values for benzene were obtained from the COSIM chemical property database, which is populated with data derived primarily from French et. al. 1996, the Merck Index (Tenth Edition, 1983) and the CRC Handbook of Chemistry and Physics 69th Edition, 1989.)

4. MODEL APPLICATION

Modeling was performed in two phases: hydrodynamic modeling using GEMSS-HDM and spill modeling using COSIM. Both were performed within the same GEMSS® framework. A detailed description of GEMSS® is provided in the Appendix.

4.1. HYDRODYNAMIC MODEL

Since the Slip is completely enclosed, the water is not subject to outside flows or tides. The only factors that influenced the hydrodynamics were the winds and changes in water volume. Groundwater sources and sinks, evaporation, precipitation, and the additional volume from the wastewater were taken into account as either a precipitation discharge into the surface of the slip, or a groundwater withdrawal from the bottom of the Slip. These sources and sinks were estimated using the daily surface elevation changes. Changes in elevation were multiplied by the surface area (249.4 ft^2) to estimate the daily volumetric flow rate into or out of the Slip.

A hydrodynamic grid (Figure 3), with 300 surface cells covering an area approximately 460 ft. in the horizontal and 160 ft. in the vertical, was created as the spatial domain for GEMSS-HDM. The computed currents were saved and used as input into the spill model.

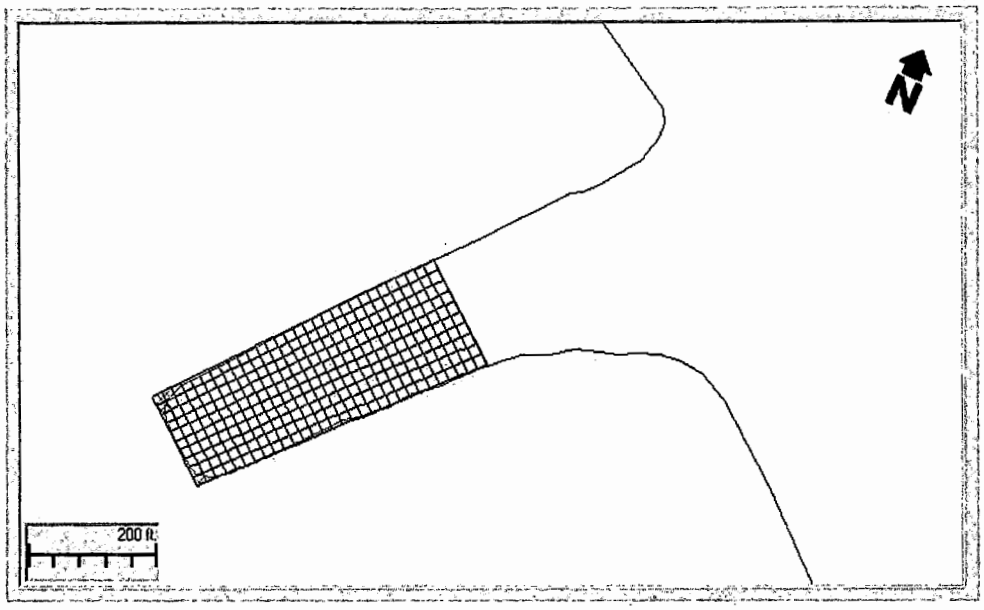

Figure 3 Hydrodynamic grid

4.2. SPILL MODEL

The spill model was run to simulate the period of time from the release on 15 February until the carbon treatment on 23 February. A shoreline spill grid was

constructed to designate which cells are shoreline and which are water (Figure 4). Particles representing the spill travel within boundaries designated by the shoreline spill grid, as a function of the spilled material's properties (viscosity, dispersion rates) and the Dissolved concentrations were computed within a separate 900 cell dynamic spill grid (Figure 5) superimposed over the shoreline spill grid. The dynamic spill grid is considered "dynamic" since the grid can expand over time to capture the spread of the modeled particles representing the spill. Concentrations at 5 depth layers were calculated hourly. COSIM initialized the model run with the spilled material in a pure produce phase before partitioning. To simulate the release as initially all dissolved benzene, the solubility was artificially magnified to force the benzene into the dissolved state within the first hourly time step.

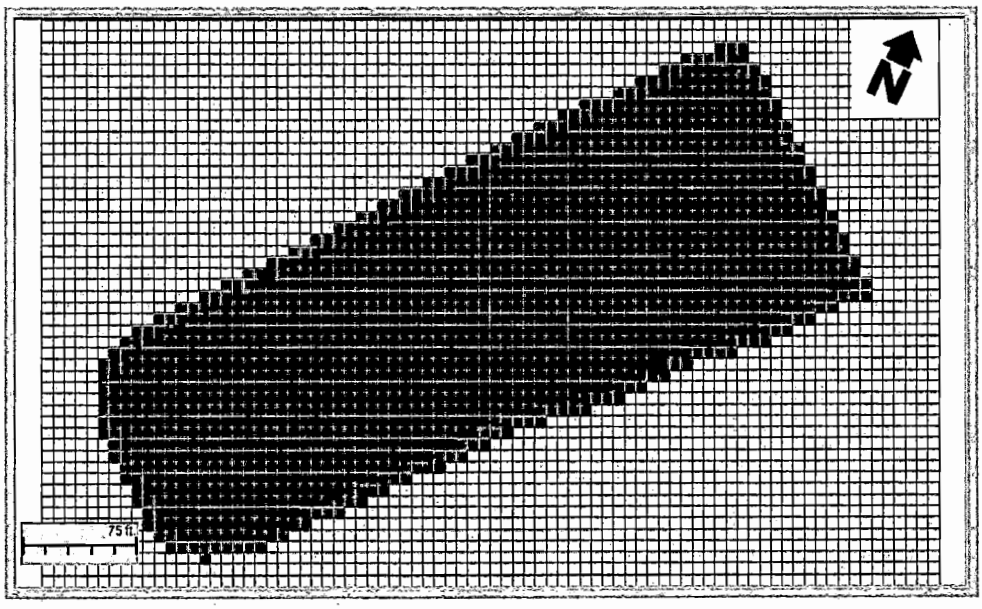

Figure 4 Shoreline Spill Grid

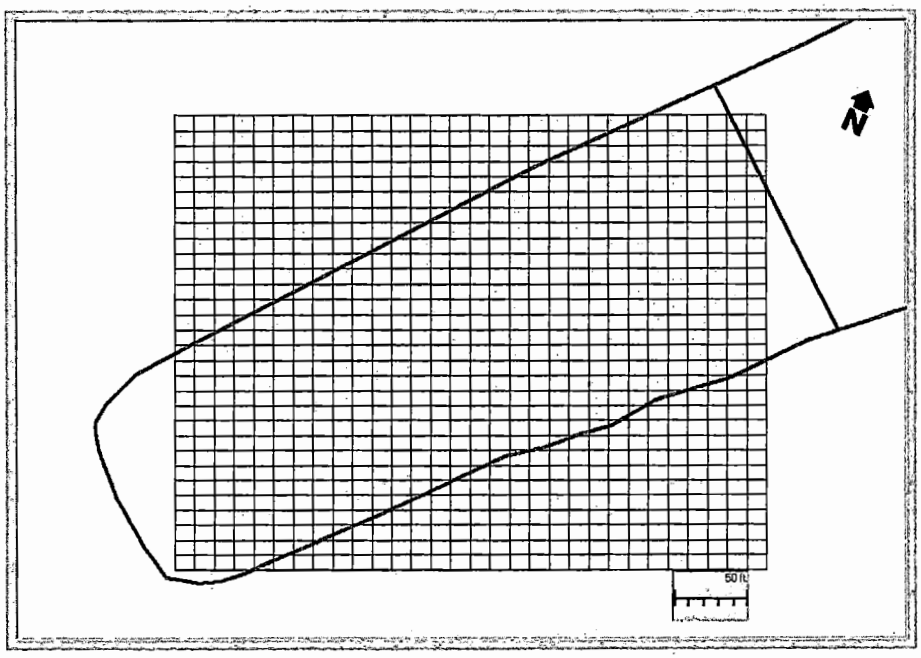

Figure 5 Dynamic Spill Grid at 15:00 on 15 February, 2007

Partitioning - Losses due to sediment partitioning are negligible. Benzene has a log octanol-water partition coefficient (Log K_{OW}) of 2.13. A simple approximation method (Thomann and Mueller, 1987) was used to determine the partition coefficient:

$$¶ (L/kg) = 0.617 (f_{OK} K_{OW})$$

where:

f_{OK} = fraction organic carbon

K_{OW} = Log octanol-water partition coefficient

The fraction of benzene sorbed to suspended solids is estimated as:

$$fp = ¶m (1+¶m)^{-1}$$

where:

m = total suspended solids (kg/L)

Given that the fraction organic carbon of the suspended solids have a range in natural waters from 0.1 to 0.001, the fraction particulate was at most 0.004% (i.e. negligible).

Biodegradation – Considering the cold temperatures and relatively short duration of the exposure, loses due to biodegradation can reasonably be assumed negligible.

Groundwater –Though groundwater flows into and out of the Slip were included by taking into account the daily changes in elevation in the Slip, mass of benzene exiting the Slip via groundwater flows were not considered in this exercise. Though mass may have traveled into the aquifer, such transport was not included since groundwater modeling would have required a separate modeling exercise to properly simulate. Rather, the model was assumed to be conservative in terms of retaining the benzene mass within the Slip for a longer time than actual. Estimates of potential groundwater contamination may be performed in a separate modeling exercise.

Agitators - Agitators were present on the Slip and functioning during the period modeled; however, the agitators were not included in the model. The presence of the agitators on the surface of the water would likely increase the amount of volatilization out from the dissolved phase, especially near the surface.

5. *MODEL RESULTS*

Results from the COSIM modeling show an exponential decrease in benzene concentrations resulting from a transfer from the water column to the atmosphere via volatilization (Figure 6). This exchange results in a decrease in water column concentrations from over 30 mg/L down to 0.4 to 3.0 mg/L within a day (Figure 7). (As a side calculation, if the entire mass of benzene were released and distributed into the volume of the slip uniformly, the resulting concentration would be 7.0 mg/L.) By 22 February, modeled concentrations were around 0.1 mg/L. Model output is provided at four locations across the slip (Figure 8).

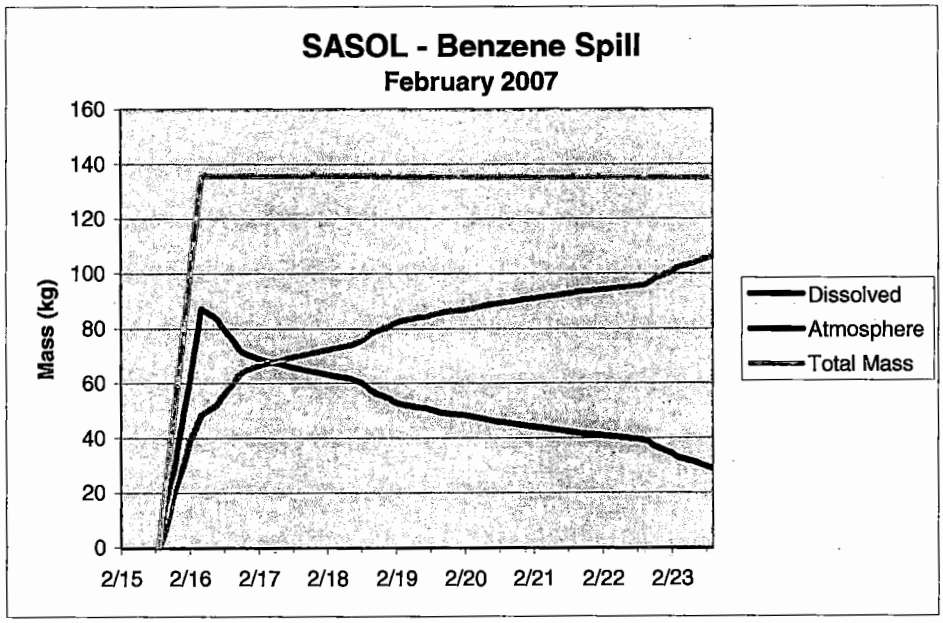

Figure 6 Modeled benzene mass balance over time

In comparison to measured benzene concentrations (Figure 9), both observed and computed values show an exponential decay in dissolved concentrations over time. However the modeled estimates show initial concentrations less mixed through the Slip than what was observed in the field. On the first day, model results had a sharp gradient in concentrations radiating from the release point, while the measured values were much more uniform. After two days, the modeled concentrations were more uniform spatially like the field values, but decreased more rapidly than the field values. By the time carbon filtration was used the following week, the modeled concentrations predicted values an order of magnitude less than what was measured.

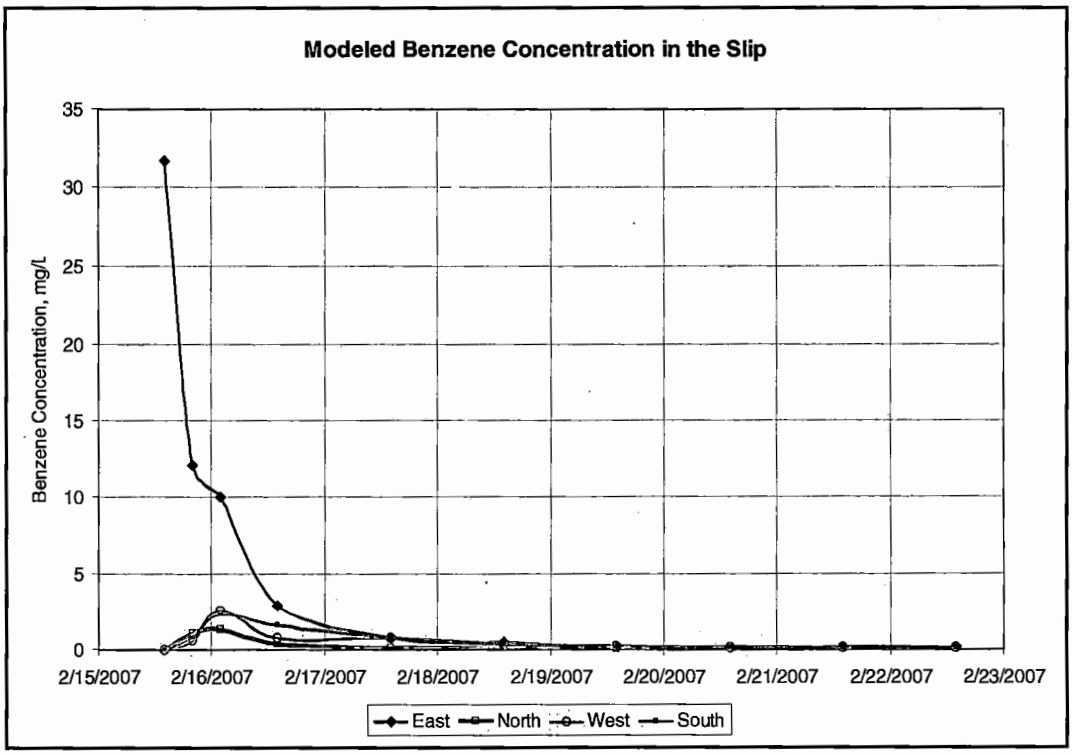

Figure 7 Modeled benzene concentrations

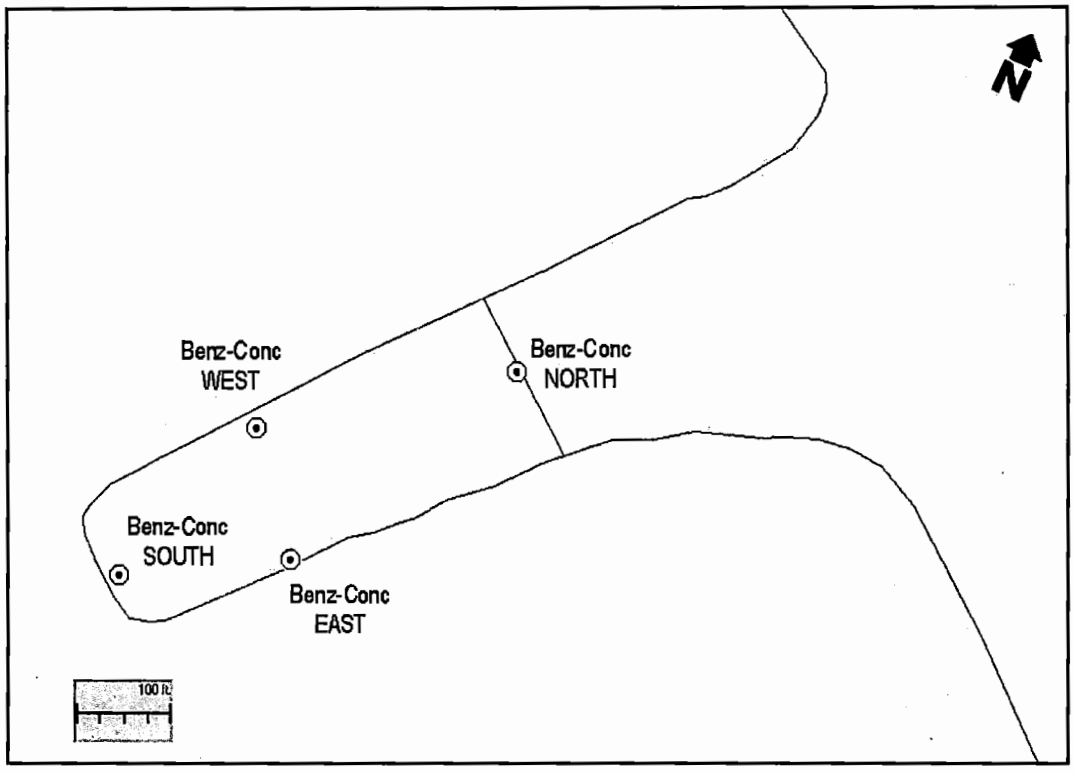

Figure 8 Locations of modeled benzene concentrations used in Figure X4

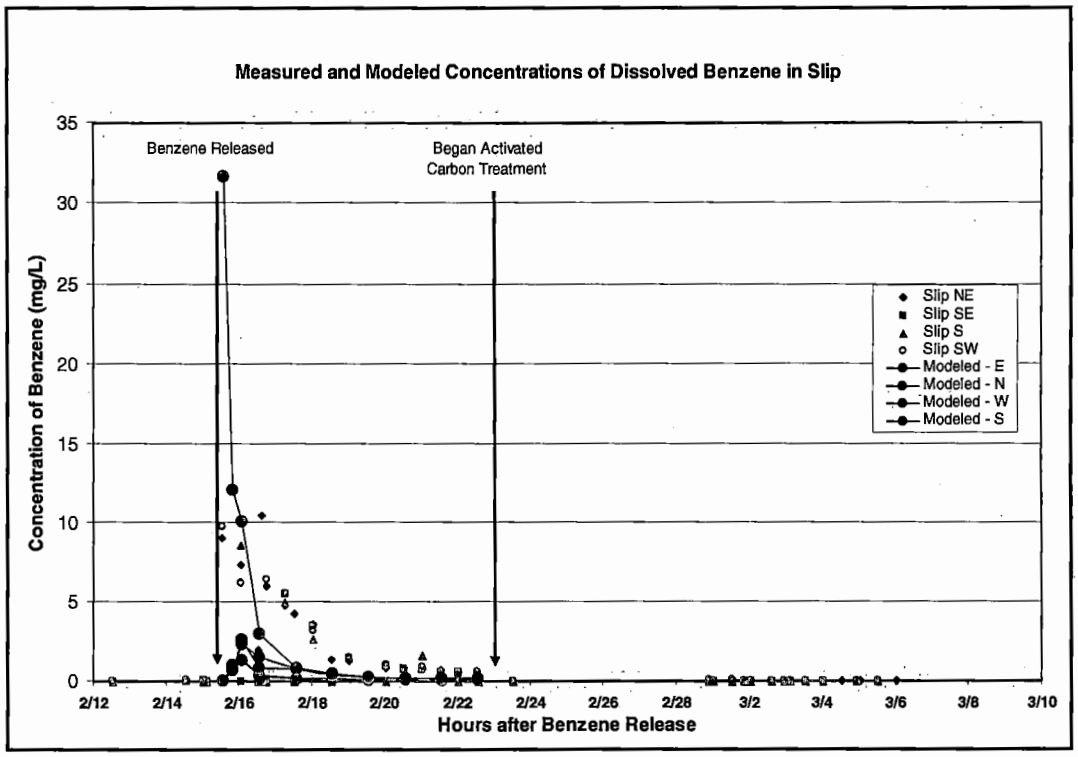

Figure 9 Measured and modeled benzene concentrations

Figure 10 through Figure 13 show surface contour plots of the modeled benzene concentrations at four times.

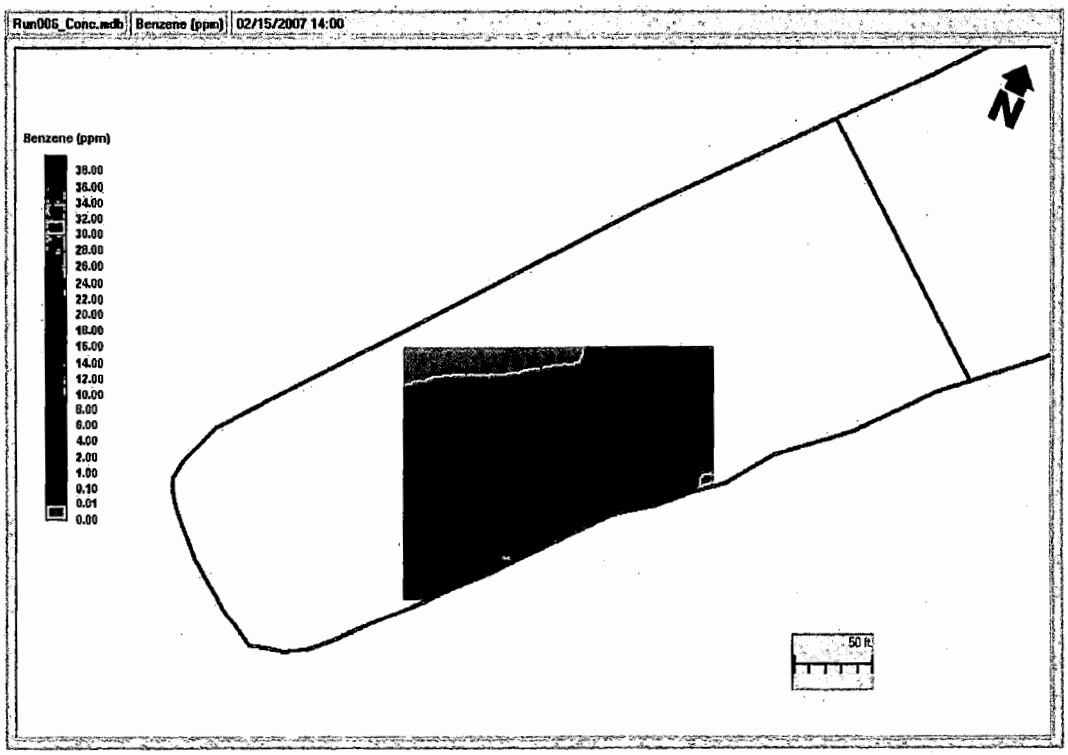

Figure 10 Modeled dissolved surface benzene concentrations Feb. 15, 2007 14:00

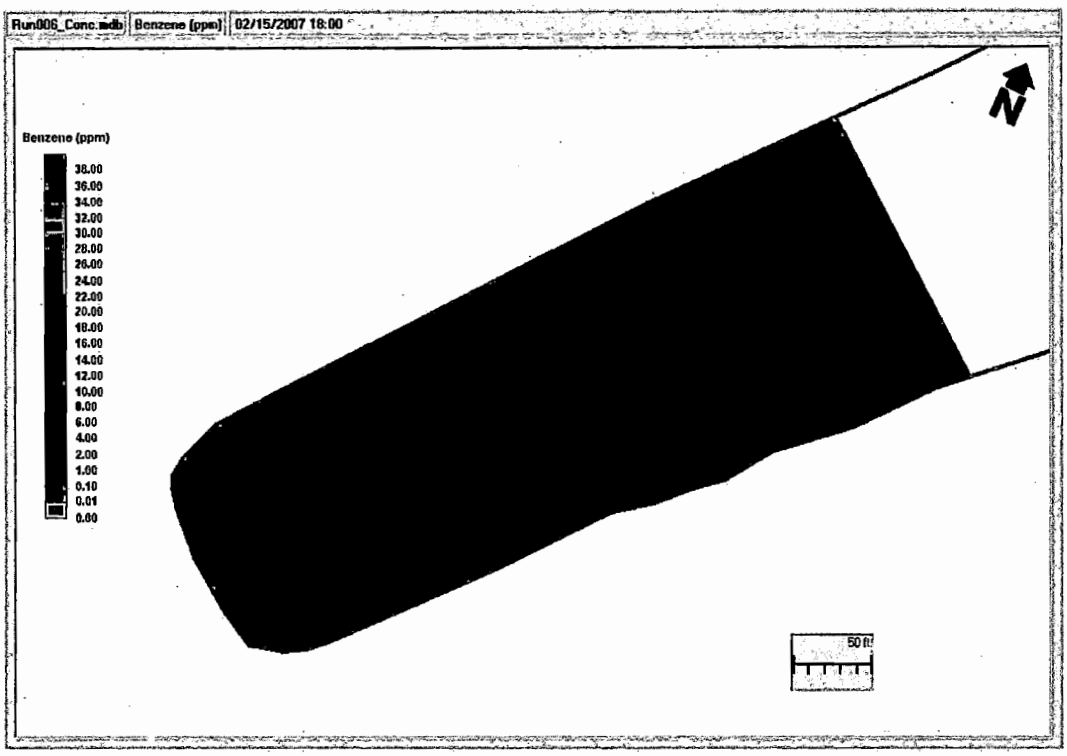

Figure 11 Modeled dissolved surface benzene concentrations Feb. 15, 2007 18:00

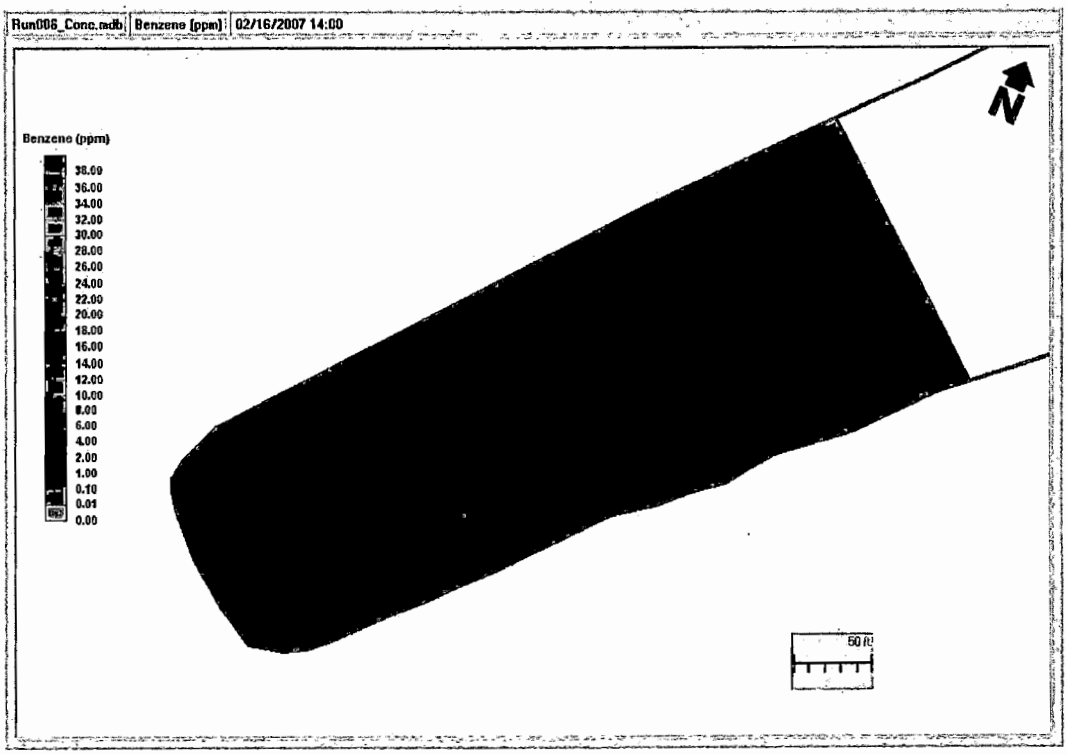

Figure 12 Modeled dissolved surface benzene concentrations Feb. 16, 2007 14:00

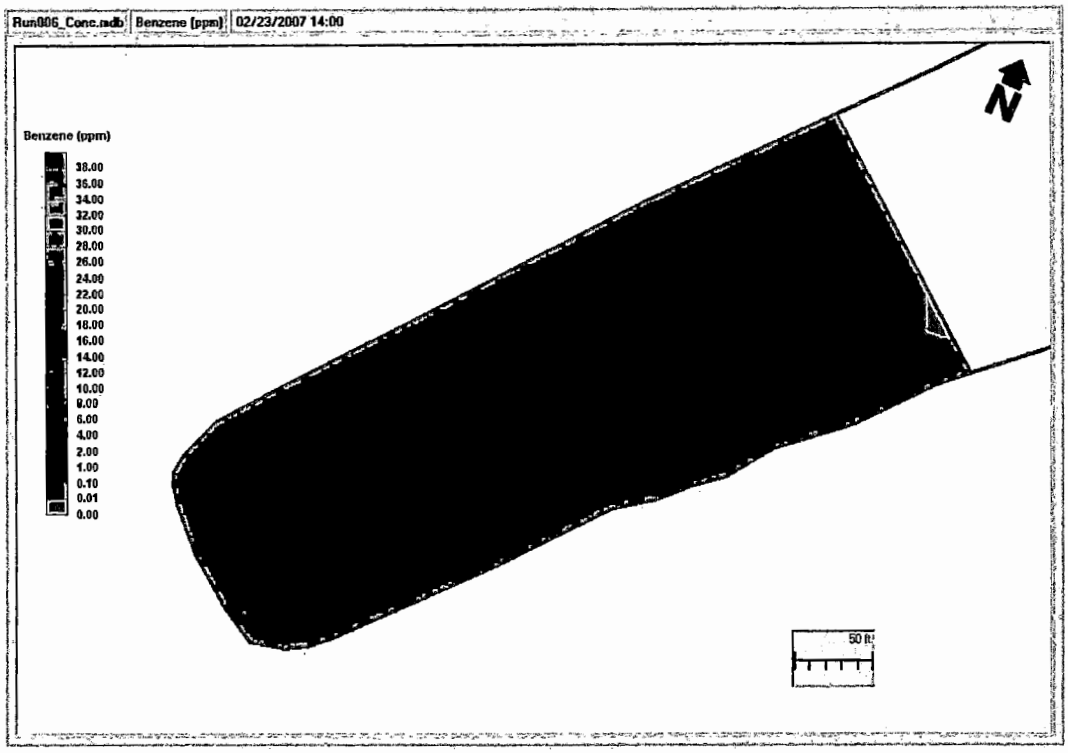

Figure 13 Modeled dissolved surface benzene concentrations Feb. 23, 2007 14:00

6. *CONCLUSIONS*

The modeling exercise performed indicated that volatilization is likely the primary cause of the reduction of dissolved benzene that was observed in the Slip over the course of 8 days after the spill. Other factors which might cause a reduction of dissolved concentrations were considered insignificant (biodegradation, sorption and sedimentation). Factors not included in the model (transport to groundwater, agitators) may have contributed to some loss, but modeling has shown that volatilization can account for all of the reductions. Modeled results were similar to those measured, showing initial concentrations in a similar range, and a pattern of exponential decay of dissolved benzene over time. However, the modeled results showed a more rapid decay from the water column than what was observed resulting in a final concentration on the eighth day an order of magnitude lower than observed. This excessive loss rate of dissolved benzene seen in the model may be the result of a need to tune the model's temperature adjustment factors for the physical properties of benzene to more appropriate values to account for the cold temperatures.

7. *REFERENCES*

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APPENDIX

GEMSS® DESCRIPTION

GEMSS includes a grid generator and editor, control file generator, 2-D and 3-D post processing viewers, and an animation tool. It uses a database approach to store and access model results. The database approach is also used for field data; as a result, the GEMSS viewers can be used to display model results, field data or both, a capability useful for understanding the behavior of the prototype as well as for calibrating the model. The field data capability can be used independently of the model application. GEMSS was developed in the mid-1980s as a hydrodynamic platform for transport and fate modeling. The hydrodynamic platform ("kernel") provides 3-D flow fields from which the distribution of various constituents can be computed. The constituent transport and fate computations are grouped into modules. GEMSS modules include hydrodynamics, thermal analysis, water quality, sediment transport, particle tracking, oil and chemical spills, entrainment, and toxics.

The theoretical basis of the hydrodynamic kernel of GEMSS is the three-dimensional Generalized, Longitudinal-Lateral-Vertical Hydrodynamic and Transport (GLLVHT) model which was first presented in Edinger and Buchak (1980) and subsequently in Edinger and Buchak (1985). The GLLVHT computation has been peer reviewed and published (Edinger and Buchak, 1995; Edinger, et al., 1994 and 1997). The kernel is an extension of the well known longitudinal-vertical transport model written by Buchak and Edinger (1984) that forms the hydrodynamic and transport basis of the Corps of Engineers' water quality model CE-QUAL-W2 (U. S. Army Engineer Waterways Experiment Station, 1986). Essential improvements to the transport scheme, construction of the constituent modules, and the incorporation of supporting software tools well as the GIS interoperability, the visualization tools, the graphical user interface (GUI), and the post-processors have been developed by Kolluru et al. (1998; 1999; 2003a; 2003b).

GEMSS and its component modules have met agency approval in the U.S. and Canada many times since 1981. GEMSS-based studies have been accepted by the U.S. Environmental Protection Agency (EPA), several U.S. state agencies including California, Massachusetts, Pennsylvania, Louisiana, Texas and Delaware. Washington State's Department of Ecology has adopted GEMSS as their standard tool for estuarine and water quality modeling. Most recently GEMSS has been published as a recommended three-dimensional hydrodynamic and water quality model in studies funded by EPA (HGL and Aqua Terra, 1999) and by the Water Environment Research Foundation (Water Environment Federation, 2001). It is the sole hydrodynamic model listed in its WERF model selection tool database for hydrodynamic and chemical fate models that can do 1-D, 2-D, and 3-D time-variable modeling for most waterbody types, all state variables, for near field and far field simulations, with GUIs, grid generation, GIS linkage, and strong documentation.

Outside the U.S., GEMSS® and its various software modules have also been approved by many regulatory agencies. Studies conducted using the hydrodynamic and thermal analysis modules (GEMSS-HDM and GEMSS-TAM, respectively) were approved by the regulatory agency in the State of Bahamas. Similar studies using the same modules were also approved by the regulatory agency in the State of Qatar. Spill impact studies conducted using the COSIM module of GEMSS® were also approved by the regulatory agency in the State of Qatar. Studies conducted using the water quality (GEMSS-WQM) module of GEMSS® were approved by the overseeing regulatory agency in India. GEMSS-HDM and GEMSS-WQM modules were recently applied to study the hydrodynamic mixing and water quality of the confluence of the Nottawasaga River with Nottawasaga Bay in Ontario, Canada. The model results were accepted by the Lake Simcoe Region Conservation Authority of Ontario, Canada. GEMSS was also used to determine the flushing potential of two proposed marinas in the Bahamas.

A GEMSS application requires two types of data: (1) spatial data, primarily the waterbody shoreline and bathymetry, but also the locations, elevations, and configurations of man-made structures and (2) temporal data, that is, time-varying boundary condition data defining tides, meteorological data, and the plant operating data. All deterministic models, GEMSS among them, require uninterrupted time-varying boundary condition data. There can be no long gaps in the datasets and all required datasets must be available during the span of the proposed simulation period.

For input to the model itself, the spatial data is encoded primarily in two input files: the control and bathymetry files. These files are geo-referenced. The temporal data is potentially encoded in many files, each file representing a set of time-varying boundary conditions, for example, meteorological data for surface heat exchange and wind shear, or inflow rates for a tributary stream. Each record in the boundary condition files is stamped with a year-month-day-hour-minute address. The data can be subjected to quality assurance procedures by using GEMSS to plot, then to visually inspect individual data points, trends and outliers. The set of input files and the GEMSS® executable constitute the model application.

APPENDIX B
LABORATORY REPORTS

Analytical Report for

ERM, Inc.

Certificate of Analysis No.: 7111307

Project Manager: Robin Guynn
Project Name : Slip Area Assessment
Project Location : Sasol NA Balto, MD
Project ID : 72890

November 20, 2007

Phase Separation Science, Inc.
6630 Baltimore National Pike
Baltimore, MD 21228
Phone: (410) 747-8770
Fax: (410) 788-8723

ROUTE 40 WEST
BALTIMORE, MD 21228
410-747-8770
800-932-9047

PHASE SEPARATION SCIENCE, INC.

November 20, 2007

Robin Guynn
ERM, Inc.
200 Harry S Truman Pkwy, Ste. 400

Annapolis, MD 21401

Reference: PSS Work Order No: **7111307**
Project Name : Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID.: 72890

Dear Robin Guynn :

The attached Analytical and QC Summary lists the analytical results from the analyses performed on the samples received under the project name referenced above and identified with the PSS Work Order numbered **7111307**.

All work reported herein has been performed in accordance with referenced methodologies, PSS SOPs and PSS QAMs. Samples will be retained by PSS for a period of 30 days following receipt. After that time, they will be properly disposed without further notice, unless there is a pre-arranged contractual agreement. PSS reserves the right to return any unused samples, extracts or related solutions. PSS is limited in liability to the actual cost of the sample analysis done.

This report shall not be reproduced except in full, without the written approval of an authorized PSS representative. A copy of this report will be retained by PSS for at least 10 years, after which time it will be disposed without further notice, unless prior arrangements have been made.

We thank you for selecting Phase Separation Science, Inc. to serve your analytical needs. If you have any questions concerning this report, do not hesitate to contact us at 410-747-8770 or info@phaseonline.com.

Sincerely,

Dan Prucnal

Dan Prucnal
Laboratory Manager

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SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 7111307
ERM, Inc., Annapolis, MD
November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SED-2 (0-1') **Date/Time Sampled: 11/12/2007 13:45** **PSS Sample ID: 7111307-001**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 41.4**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	**2,900**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035
Toluene	**44**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035
Ethylbenzene	**360**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035
m,p-Xylenes	**720**	ug/kg	48		10	11/15/07	11/15/07 14:42	1035
o-Xylene	**190**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035

Sample ID: SED-3 (0-1') **Date/Time Sampled: 11/12/2007 13:55** **PSS Sample ID: 7111307-002**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 21.7**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035
Toluene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035
Ethylbenzene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035
m,p-Xylenes	**51**	ug/kg	46		5	11/15/07	11/15/07 15:12	1035
o-Xylene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035

Sample ID: SED-4 (0-1') **Date/Time Sampled: 11/12/2007 13:30** **PSS Sample ID: 7111307-003**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 53.5**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	**23**	ug/kg	19		10	11/15/07	11/15/07 15:42	1035
Toluene	ND	ug/kg	19		10	11/15/07	11/15/07 15:42	1035
Ethylbenzene	**31**	ug/kg	19		10	11/15/07	11/15/07 15:42	1035
m,p-Xylenes	**120**	ug/kg	37		10	11/15/07	11/15/07 15:42	1035
o-Xylene	**67**	ug/kg	19		10	11/15/07	11/15/07 15:42	1035

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CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SED-6 (0-1') **Date/Time Sampled: 11/12/2007 14:05** **PSS Sample ID: 7111307-004**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 35.2**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/kg	28		10	11/15/07	11/15/07 16:12	1035
Toluene	ND	ug/kg	28		10	11/15/07	11/15/07 16:12	1035
Ethylbenzene	**34**	ug/kg	28		10	11/15/07	11/15/07 16:12	1035
m,p-Xylenes	**82**	ug/kg	57		10	11/15/07	11/15/07 16:12	1035
o-Xylene	**73**	ug/kg	28		10	11/15/07	11/15/07 16:12	1035

Sample ID: SED-7 (0-1') **Date/Time Sampled: 11/12/2007 13:35** **PSS Sample ID: 7111307-005**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 48.0**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/kg	21		10	11/15/07	11/15/07 16:42	1035
Toluene	ND	ug/kg	21		10	11/15/07	11/15/07 16:42	1035
Ethylbenzene	**22**	ug/kg	21		10	11/15/07	11/15/07 16:42	1035
m,p-Xylenes	**120**	ug/kg	42		10	11/15/07	11/15/07 16:42	1035
o-Xylene	**88**	ug/kg	21		10	11/15/07	11/15/07 16:42	1035

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CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-1 **Date/Time Sampled: 11/12/2007 13:15** **PSS Sample ID: 7111307-006**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Inorganic Anions — Analytical Method: EPA 300.0 — Preparation Method: E300PREP

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Chloride	**140**	mg/L	2		20	11/14/07	11/14/07 17:30	1011
Sulfate	**67**	mg/L	2		20	11/14/07	11/14/07 17:30	1011

Dissolved Metals — Analytical Method: SW846 6020A — Preparation Method: SW3005A

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Iron	ND	ug/L	100		1	11/16/07	11/16/07 13:05	1034

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 14:13	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035

Dissolved Gases in Water — Analytical Method: SW846 SM6221B/8015

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Methane	**0.0057**	mg/L	0.0057		1	11/15/07	11/15/07 00:00	4010

Alkalinity — Analytical Method: Standard Methods 2320B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	**68**	mg/L	5		1	11/19/07	11/19/07 10:15	4005

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CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-1 **Date/Time Sampled: 11/12/2007 13:15** **PSS Sample ID: 7111307-006**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Residue, Non-Filterable — Analytical Method: Standard Methods 2540D

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Suspended Solids	**5**	mg/L	1		1	11/16/07	11/16/07 11:50	1034

Total Organic Carbon — Analytical Method: Standard Methods 5310B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Total Organic Carbon	**1.5**	mg/L	1		1	11/15/07	11/15/07 08:00	4001

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CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-2 **Date/Time Sampled: 11/12/2007 13:00** **PSS Sample ID: 7111307-007**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Inorganic Anions — Analytical Method: EPA 300.0 — Preparation Method: E300PREP

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Chloride	**140**	mg/L	2		20	11/14/07	11/14/07 17:46	1011
Sulfate	**67**	mg/L	2		20	11/14/07	11/14/07 17:46	1011

Dissolved Metals — Analytical Method: SW846 6020A — Preparation Method: SW3005A

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Iron	ND	ug/L	100		1	11/16/07	11/16/07 13:28	1034

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 14:42	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035

Dissolved Gases in Water — Analytical Method: SW846 SM6221B/8015

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Methane	ND	mg/L	0.0059		1	11/15/07	11/15/07 00:00	4010

Alkalinity — Analytical Method: Standard Methods 2320B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	**70**	mg/L	5		1	11/19/07	11/19/07 10:15	4005

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SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-2 **Date/Time Sampled: 11/12/2007 13:00** **PSS Sample ID: 7111307-007**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Residue, Non-Filterable — Analytical Method: Standard Methods 2540D

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Suspended Solids	4	mg/L	1		1	11/16/07	11/16/07 11:50	1034

Total Organic Carbon — Analytical Method: Standard Methods 5310B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Total Organic Carbon	2.1	mg/L	1		1	11/15/07	11/15/07 08:00	4001

Sample ID: SW-3 **Date/Time Sampled: 11/12/2007 13:20** **PSS Sample ID: 7111307-008**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 15:10	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035

Sample ID: TB-1 (11/12/07) **Date/Time Sampled: 11/12/2007 13:10** **PSS Sample ID: 7111307-009**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 13:45	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

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(1) CLIENT: ERM Inc PHONE NO.: (410) 2660006
PROJECT MGR: Robin Guynn FAX NO.: (410) 2668912
EMAIL: robin.guynn@erm.com
PROJECT NAME: Slip Area Assessment -
SITE LOCATION: Sasol NA Balto, MD
PROJECT NO.: 72890 P.O. NO.:

PSS Project #: 711307

PAGE 1 OF 1

(2)

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX	No. CONTAINERS	SAMPLE TYPE C = COMP G = GRAB	Preservatives Used										REMARKS
	Analysis Required (3)							BTEX, total	Sal + Cl	Alk	Diss. CN	Diss. Fe	TSS	TOC			
1	SED-2 (0-1')	11/12/07	1345	Sediment	1	G		X									
2	SED-3 (0-1')		1355		1			X									
3	SED-4 (0-1')		1330		1			X									
4	SED-6 (0-1')		1405		1			X									
5	SED-7 (0-1')		1335		1			X									
6	SW-1		1315	Water	11			X	X	X	X	X	X	X			
7	SW-2		1300		11			X	X	X	X	X	X	X			
8	SW-3		1320		3			X									
9	TB-1 (11/12/07)		1310		2			X									

(5)

Collected / Relinquished By: (1)	Date	Time	Received By:
T. Polemeli	11/13/07	0800	
Relinquished By: (2)	Date	Time	Received By:
	11/13/07	1400	
Relinquished By: (3)	Date	Time	Received By:
Collected / Relinquished By: (4)	Date	Time	Received By:

(4)

Requested Turnaround Time
[X] 5-Day (Std.) [ ] 3-Day [ ] 2-Day
[ ] Next Day [ ] Emergency [ ] Other

Sample Condition Upon Receipt: Cooler + Ice
Custody Seal: n/a 2.4°C

Data Deliverables Required: VCP Type PKG

Shipping Carrier: Dial
Shipping Ticket No.: n/a

Special Instructions:
Dissolved Fe was Field Filtered
TOC will be preserved @ Lab.

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Phase Separation Science, Inc

Sample Receipt Checklist

Wo Number	7111307	**Received By**	Rachel Davis
Client Name	ERM, Inc.	**Date Received**	11/13/2007 02:00:00 PM
Project Name	Slip Are Assessment	**Delivered_By**	Dial Courier
Project Number	72890	**Tracking No**	Not Applicable

Packaging

No of Coolers	1	Ice	PRES
Custody Seals	Absent	Temp (deg C)	2.4
Seal Signed/Dated	No	Temp Blank Present	No

Documentation

COC agrees with sample labels? X Yes or ___ No

Chain of Custody (COC) X Yes or ___ No

Sample Container

Appropiate for Specified Analysis?	Yes X	No ___	Custody Seal	Yes ___	No X
Intact?	X	___	Custody Seal Intact?	___	X
Labeled and Labels Legible	X	___	Signed / Dated	___	X
Total No of Samples Received	9		Total No Containers Received	32	

Preservation (Waters)

		Yes	No	N/A
Metals	(pH<2)	X	___	___
Cyanides	(pH>12)	___	___	X
Sulfide	(pH>9)	___	___	X
TOC, COD, Phenols	(pH<2)	X	___	___
TOX, TKN, NH3, Total Phos	(pH<2)	___	___	X
VOC, BTEX (VOA Vials Rcvd Preserved)	(pH<2)	X	___	___
Do VOA vials have zero headspace?		X	___	___

Comments: (Any No response must be detailed in the comments section below.)

For any improper preservation conditions, list sample ID, preservative added (reagent ID number) below as well as documentation of any client notification as well as client instructions.

*One HCL preserved 40ml vial will be used for TOC
-rd 11/13/07

Checklist Completed By: R Davis Date: 11/13/7

PM Review and Approval: AB Date: 11/14/07

Analytical Report for

ERM, Inc.

Certificate of Analysis No.: 7111307

Project Manager: Robin Guynn
Project Name : Slip Area Assessment
Project Location : Sasol NA Balto, MD
Project ID : 72890

November 20, 2007

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PHASE SEPARATION SCIENCE, INC.

November 20, 2007

Robin Guynn
ERM, Inc.
200 Harry S Truman Pkwy, Ste. 400

Annapolis, MD 21401

Reference: PSS Work Order No: **7111307**
Project Name : Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID.: 72890

Dear Robin Guynn :

The attached Analytical and QC Summary lists the analytical results from the analyses performed on the samples received under the project name referenced above and identified with the PSS Work Order numbered **7111307**.

All work reported herein has been performed in accordance with referenced methodologies, PSS SOPs and PSS QAMs. Samples will be retained by PSS for a period of 30 days following receipt. After that time, they will be properly disposed without further notice, unless there is a pre-arranged contractual agreement. PSS reserves the right to return any unused samples, extracts or related solutions. PSS is limited in liability to the actual cost of the sample analysis done.

This report shall not be reproduced except in full, without the written approval of an authorized PSS representative. A copy of this report will be retained by PSS for at least 10 years, after which time it will be disposed without further notice, unless prior arrangements have been made.

We thank you for selecting Phase Separation Science, Inc. to serve your analytical needs. If you have any questions concerning this report, do not hesitate to contact us at 410-747-8770 or info@phaseonline.com.

Sincerely,

Dan Prucnal

Dan Prucnal
Laboratory Manager

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SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SED-2 (0-1') **Date/Time Sampled: 11/12/2007 13:45** **PSS Sample ID: 7111307-001**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 41.4**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	**2,900**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035
Toluene	**44**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035
Ethylbenzene	**360**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035
m,p-Xylenes	**720**	ug/kg	48		10	11/15/07	11/15/07 14:42	1035
o-Xylene	**190**	ug/kg	24		10	11/15/07	11/15/07 14:42	1035

Sample ID: SED-3 (0-1') **Date/Time Sampled: 11/12/2007 13:55** **PSS Sample ID: 7111307-002**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 21.7**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035
Toluene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035
Ethylbenzene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035
m,p-Xylenes	**51**	ug/kg	46		5	11/15/07	11/15/07 15:12	1035
o-Xylene	ND	ug/kg	23		5	11/15/07	11/15/07 15:12	1035

Sample ID: SED-4 (0-1') **Date/Time Sampled: 11/12/2007 13:30** **PSS Sample ID: 7111307-003**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 53.5**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	**23**	ug/kg	19		10	11/15/07	11/15/07 15:42	1035
Toluene	ND	ug/kg	19		10	11/15/07	11/15/07 15:42	1035
Ethylbenzene	**31**	ug/kg	19		10	11/15/07	11/15/07 15:42	1035
m,p-Xylenes	**120**	ug/kg	37		10	11/15/07	11/15/07 15:42	1035
o-Xylene	**67**	ug/kg	19		10	11/15/07	11/15/07 15:42	1035

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SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SED-6 (0-1') **Date/Time Sampled: 11/12/2007 14:05** **PSS Sample ID: 7111307-004**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 35.2**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/kg	28		10	11/15/07	11/15/07 16:12	1035
Toluene	ND	ug/kg	28		10	11/15/07	11/15/07 16:12	1035
Ethylbenzene	**34**	ug/kg	28		10	11/15/07	11/15/07 16:12	1035
m,p-Xylenes	**82**	ug/kg	57		10	11/15/07	11/15/07 16:12	1035
o-Xylene	**73**	ug/kg	28		10	11/15/07	11/15/07 16:12	1035

Sample ID: SED-7 (0-1') **Date/Time Sampled: 11/12/2007 13:35** **PSS Sample ID: 7111307-005**
Matrix: SEDIMENT (ASSOC **Date/Time Received: 11/13/2007 14:00** **% Solids: 48.0**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/kg	21		10	11/15/07	11/15/07 16:42	1035
Toluene	ND	ug/kg	21		10	11/15/07	11/15/07 16:42	1035
Ethylbenzene	**22**	ug/kg	21		10	11/15/07	11/15/07 16:42	1035
m,p-Xylenes	**120**	ug/kg	42		10	11/15/07	11/15/07 16:42	1035
o-Xylene	**88**	ug/kg	21		10	11/15/07	11/15/07 16:42	1035

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SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-1 **Date/Time Sampled: 11/12/2007 13:15** **PSS Sample ID: 7111307-006**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Inorganic Anions — Analytical Method: EPA 300.0 — Preparation Method: E300PREP

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Chloride	**140**	mg/L	2		20	11/14/07	11/14/07 17:30	1011
Sulfate	**67**	mg/L	2		20	11/14/07	11/14/07 17:30	1011

Dissolved Metals — Analytical Method: SW846 6020A — Preparation Method: SW3005A

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Iron	ND	ug/L	100		1	11/16/07	11/16/07 13:05	1034

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 14:13	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 14:13	1035

Dissolved Gases in Water — Analytical Method: SW846 SM6221B/8015

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Methane	**0.0057**	mg/L	0.0057		1	11/15/07	11/15/07 00:00	4010

Alkalinity — Analytical Method: Standard Methods 2320B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	**68**	mg/L	5		1	11/19/07	11/19/07 10:15	4005

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SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-1 **Date/Time Sampled: 11/12/2007 13:15** **PSS Sample ID: 7111307-006**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Residue, Non-Filterable — Analytical Method: Standard Methods 2540D

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Suspended Solids	**5**	mg/L	1		1	11/16/07	11/16/07 11:50	1034

Total Organic Carbon — Analytical Method: Standard Methods 5310B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Total Organic Carbon	**1.5**	mg/L	1		1	11/15/07	11/15/07 08:00	4001

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SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-2 **Date/Time Sampled: 11/12/2007 13:00** **PSS Sample ID: 7111307-007**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Inorganic Anions — Analytical Method: EPA 300.0 — Preparation Method: E300PREP

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Chloride	**140**	mg/L	2		20	11/14/07	11/14/07 17:46	1011
Sulfate	**67**	mg/L	2		20	11/14/07	11/14/07 17:46	1011

Dissolved Metals — Analytical Method: SW846 6020A — Preparation Method: SW3005A

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Iron	ND	ug/L	100		1	11/16/07	11/16/07 13:28	1034

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 14:42	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 14:42	1035

Dissolved Gases in Water — Analytical Method: SW846 SM6221B/8015

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Methane	ND	mg/L	0.0059		1	11/15/07	11/15/07 00:00	4010

Alkalinity — Analytical Method: Standard Methods 2320B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	**70**	mg/L	5		1	11/19/07	11/19/07 10:15	4005

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CERTIFICATE OF ANALYSIS

No: 7111307

ERM, Inc., Annapolis, MD

November 20, 2007

Project Name: Slip Area Assessment
Project Location: Sasol NA Balto, MD
Project ID: 72890

Sample ID: SW-2 **Date/Time Sampled: 11/12/2007 13:00** **PSS Sample ID: 7111307-007**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Residue, Non-Filterable — Analytical Method: Standard Methods 2540D

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Suspended Solids	**4**	mg/L	1		1	11/16/07	11/16/07 11:50	1034

Total Organic Carbon — Analytical Method: Standard Methods 5310B

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Total Organic Carbon	**2.1**	mg/L	1		1	11/15/07	11/15/07 08:00	4001

Sample ID: SW-3 **Date/Time Sampled: 11/12/2007 13:20** **PSS Sample ID: 7111307-008**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 15:10	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 15:10	1035

Sample ID: TB-1 (11/12/07) **Date/Time Sampled: 11/12/2007 13:10** **PSS Sample ID: 7111307-009**
Matrix: WATER **Date/Time Received: 11/13/2007 14:00**

Purgeable Aromatics — Analytical Method: SW846 8021B — Preparation Method: SW5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	Rep Limit	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035
Toluene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035
Ethylbenzene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035
m,p-Xylenes	ND	ug/L	2		1	11/15/07	11/15/07 13:45	1035
o-Xylene	ND	ug/L	1		1	11/15/07	11/15/07 13:45	1035

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

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(1) CLIENT: ERM Inc PHONE NO.: (410) 2660006
PROJECT MGR: Robin Guynn FAX NO.: (410) 2668912
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PROJECT NAME: Sisl Area Assessment -
SITE LOCATION: Sasol NA Balto, MD
PROJECT NO.: 72890 P.O. NO.:

PSS Project #: 711307

PAGE 1 OF 1

(2)

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX	No. CONTAINERS	SAMPLE TYPE C=COMP G=GRAB	Preservatives Used	Analysis Required (3) BTEX, total	Soy + Cl	AIK	Diss. CN+	Diss. Fe	TSS	TOC	REMARKS
							Nil	-	-	-	ANY	-	-		
1	SED-2 (0-1')	11/12/07	1345	Sediment	1	G		X							
2	SED-3 (0-1')		1355		1			X							
3	SED-4 (0-1')		1330		1			X							
4	SED-6 (0-1')		1405		1			X							
5	SED-7 (0-1')		1335	↓	1			X							
6	SW-1		1315	Water	11			X	X	X	X	X	X	X	
7	SW-2		1300		11			X	X	X	X	X	X	X	
8	SW-3		1320		3			X							
9	TB-1 (11/12/07)	↓	1310	↓	2	↓		X							

(5)

Collected / Relinquished By: (1)	Date	Time	Received By:
T. Polemski	11/13/07	0800	
Relinquished By: (2)	Date	Time	Received By:
	11/13/07	1400	
Relinquished By: (3)	Date	Time	Received By:
Collected / Relinquished By: (4)	Date	Time	Received By:

(4)

Requested Turnaround Time
☒ 5-Day (Std.) ☐ 3-Day ☐ 2-Day
☐ Next Day ☐ Emergency ☐ Other

Sample Condition Upon Receipt: Cooler + Ice 2.4°C
Custody Seal: n/a

Data Deliverables Required: VCP Type PKG

Shipping Carrier: Client
Shipping Ticket No.: n/a

Special Instructions:
Dissolved Fe was Field Filtered
TOC will be preserved @ Lab.

Phase Separation Science, Inc

Sample Receipt Checklist

Wo Number	7111307	**Received By**	Rachel Davis
Client Name	ERM, Inc.	**Date Received**	11/13/2007 02:00:00 PM
Project Name	Slip Are Assessment	**Delivered_By**	Dial Courier
Project Number	72890	**Tracking No**	Not Applicable

Packaging

No of Coolers	1	Ice	PRES
Custody Seals	Absent	Temp (deg C)	2.4
Seal Signed/Dated	No	Temp Blank Present	No

Documentation

COC agrees with sample labels? X Yes or ___ No

Chain of Custody (COC) X Yes or ___ No

Sample Container

Appropiate for Specified Analysis?	Yes X No ___	Custody Seal	Yes ___ No X
Intact?	X ___	Custody Seal Intact?	___ X
Labeled and Labels Legible	X ___	Signed / Dated	___ X
Total No of Samples Received	9	Total No Containers Received	32

Preservation (Waters)

		Yes	No	N/A
Metals	(pH<2)	X	___	___
Cyanides	(pH>12)	___	___	X
Sulfide	(pH>9)	___	___	X
TOC, COD, Phenols	(pH<2)	X*	___	___
TOX, TKN, NH3, Total Phos	(pH<2)	___	___	X
VOC, BTEX (VOA Vials Rcvd Preserved)	(pH<2)	X	___	___
Do VOA vials have zero headspace?		X	___	___

Comments: (Any No response must be detailed in the comments section below.)

For any improper preservation conditions, list sample ID, preservative added (reagent ID number) below as well as documentation of any client notification as well as client instructions.

*One HCL preserved 40ml vial will be used for TOC
-rd 11/13/07

Checklist Completed By: R. Davis Date: 11/13/7

PM Review and Approval: AB Date: 11/14/07